

New species of the genus *Tritogenia* Kinberg, 1867 from southern Africa (Oligochaeta: Microchaetidae)

by

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ABSTRACT

Eighteen new species of *Tritogenia* are described and illustrated: *alveata*, *annetteae*, *ataxia*, *curiosa*, *diversa*, *douglasi*, *herbana*, *insolita*, *koilia*, *liversagei*, *lunata*, *miniseta*, *monosticha*, *ngelensis*, *palusicola*, *silvicola*, *soleata*, *turneri*. All known species are arranged into four species-groups based on the position of spermathecal pores: the *grisea* group with spermathecal pores in one intersegmental furrow (including provisionally the poorly known species *benhami* (Michaelson, 1900)); the *sulcata* group with spermathecal pores in two intersegmental furrows; the *mucosa* species-group with spermathecal pores in three intersegmental furrows; and the *zuluensis* group with spermathecal pores in more than three intersegmental furrows. Keys are provided to the genera of Microchaetidae, to the newly proposed species-groups, and to the species of *Tritogenia*.

INTRODUCTION

Tritogenia was described by Kinberg (1867) for *sulcata*, as the third genus of Microchaetidae. Michaelsen (1899 1900 1913 1918) provided descriptions of new species and revised previously known ones, finally recognising five: *sulcata* Kinberg, 1867, *benhami* (Michaelsen, 1900), *morosa* Cognetti, 1906, *howickiana* (Michaelsen, 1913), and *crassa* Michaelsen, 1918. Much later more species were added or transferred from other genera to *Tritogenia*. Plisko & Zicsi (1991) transferred *grisea* (Michaelsen, 1902) from *Microchaetus* Rapp, 1849, and described: *curta*, *kruegeri*, *karkloofia*, *mucosa*, and *shawi*. Plisko (1992) described *ngomensis*, and following a suggestion by Reynolds & Cook (1976) on *melmothanus* (Michaelsen, 1928), transferred this species and *zuluensis* (Beddard, 1907) to *Tritogenia*, raising the number of species to 14. However, the identities of *benhami* and *morosa* are still uncertain. The depository of the type material of *benhami* is unknown (Reynolds & Cook 1976), and its type locality was not recorded. The original descriptions were not adequate for the recognition of species with spermathecal pores in 12/13 intersegmental furrow, and no species with spermathecal pores only in 11/12 intersegmental furrow are known from the material available. The data for *morosa* suggest that it could be a synonym of *sulcata* (Michaelsen 1918).

During years of collecting megadrile Oligochaeta in southern Africa, a large collection of undescribed microchaetids was accumulated in the Natal Museum. Study of the material resulted in the discovery of 17 new species of the genus *Tritogenia*. Additionally, during recent study of the collection of microchaetids in The Natural History Museum in London, a misidentified specimen proved to represent a new species of *Tritogenia*, and is also described in this paper. The genus now contains 31 species.

Recent investigations reveal that the position of spermathecae and their pores are significant characters, useful for grouping species and constructing keys. All species of *Tritogenia* currently recognised are arranged in four groups: the *grisea*, *mucosa*, *sulcata*, and *zuluensis* species-groups, based on the location of spermathecal pores.

Keys are provided to the genera of Microchaetidae, the newly proposed species-groups, and the species of the *grisea*, *sulcata* and *mucosa* species-groups, to distinguish the new species from those previously known.

MATERIAL AND METHODS

Most material studied was collected by me with field assistance provided at various times by Dr B. R. Stuckenberg, Mr T. Liversage, Dr J. H. H. Londt, Mrs A. Seymour-Kunz, Mr D. McCulloch and Mr B. Howells. The type material for *T. turneri* sp. n. was collected and donated to the Natal Museum by Mr J. Turner. All of the material is deposited in the Natal Museum Oligochaeta Collection, with the exception of the type specimen of *T. soleata* sp. n., which is deposited in the Oligochaeta Collection of The Natural History Museum (London).

Coordinates are provided (in brackets) for all place names recorded on the original labels. This information was obtained from the Reader's Digest *Atlas of Southern Africa* (1984), and the *Preliminary NIS Gazetteer of South Africa* (1954). Information provided under the heading 'material examined' is derived entirely from specimen labels. The names given to the provinces of the Republic of South Africa after April 1994, are used. If they differ from those previously used, the original name is listed below in the right hand column. Drawings were made with the aid of a drawing-tube attached to a WILD stereo microscope; photographs were taken using a WILD photo microscope.

Glossary and abbreviations:

BMNH	– The Natural History Museum, London, England
BRS	– B. R. Stuckenberg
DMcC	– D. McCulloch
Free State	– Orange Free State Province
JDP	– J. D. Plisko
KwaZulu-Natal	– Natal Province
NMSA	– Natal Museum, Pietermaritzburg, South Africa
NMSA/Olig.	– Oligochaeta Collection, Natal Museum
Mpumalanga	– south-eastern Transvaal
Northern Province	– northern Transvaal
North West Province	– north-western Transvaal
TL	– T. Liversage
u	– abbreviation of German word 'Umfang' ¹

1/n followed by a number, means part of that segment indicated by the number.

¹This word means the circumference of the body, and was used by earlier authors in papers dealing with microchaetids.

TAXONOMY

Key to genera of Microchaetidae

- 1 One oesophageal gizzard.....2
- Two oesophageal gizzards, one in 7 extending into 6, second in 9.....**Michalakus**
- 2 One pair of nephridia per segment.....3
- More than one pair of nephridia per segment.....**Tritogenia**
- 3 Holandric.....**Microchaetus**
- Proandric.....**Proandricus**

Tritogenia Kinberg, 1867

Tritogenia Kinberg, 1867: 97. Type species: *T. sulcata* Kinberg, 1867.

Diagnosis: Preclitellar segments with secondary, external annulation. Setae minute, closely paired, in regular longitudinal rows, or irregularly located. Male pores intraclitellar. Spermathecal pores in front of male pores. Spermathecae paired or multiple. One oesophageal gizzard in the area of segments 6–7. Calciferous glands with or without stalks, in segments 9–10. Nephridia meronephridia; small, in postclitellar segments more than one pair per segment. Holandric (testes and spermiductal funnels in segments 10 and 11). With or without papillae. Genital glands present or absent.

Terrestrial, living in soils of primary grassland, savannas, natural forests, riparian sites, or where ground is not disturbed by agriculture or industry. Excrements are deposited in the soil in the form of small clods, or on the surface as casts.

Thirty one described species. The genus is known only from eastern and north-eastern South Africa. The main concentration of species is in KwaZulu-Natal; other species occur in the higher eastern parts of the interior plateau, the northern Drakensberg escarpments, and the eastern part of the Soutpansberg Range.

DESCRIPTION OF SPECIES-GROUPS

In this paper the separation of species has been based on the position of spermathecal pores, shape and position of the clitellum and tubercula pubertatis, and on the condition of calciferous glands. Data on the location of spermathecal pores enable all known species of the genus to be arranged in groups as described below. New species are described in the first three groups; no species for the *zuluensis* group were added.

The *grisea* species-group, characterised by only one row of spermathecal pores, includes five species: *benhami* (anatomical features uncertain, with spermathecal pores in intersegmental furrow 11/12 or 12/13), and *grisea*, *kruegeri*, *ngomensis* and *monosticha* with spermathecal pores in the 12/13 intersegmental furrow.

The *sulcata* species-group with spermathecal pores in two intersegmental furrows, incorporates 16 species: *shawi* and *soleata*, with spermathecal pores in intersegmental furrows 10/11, 11/12, and *annetteae*, *ataxia*, *curta*, *diversa*, *douglasi*, *herbana*, *howickiana*, *karkloofia*, *lunata*, *miniseta*, *ngelensis*, *palusicola*, and *sulcata* with spermathecal pores in 11/12, 12/13, and *curiosa* with spermathecal pores in 12/13, 13/14.

TABLE 1
Tritogenia species arranged in groups according to the number of intersegmental furrows (NIF) with spermathecal pores.

NIF	Intersegmental furrows								Species
	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	
1	-	-	+	-	-	-	-	-	<i>grisea</i> , <i>kruegeri</i> , <i>ngomensis</i> , <i>monosticha</i> ;
2	+	+	-	-	-	-	-	-	<i>Shawi</i> , <i>soleata</i> ;
		+	+	-	-	-	-	-	<i>annetteae</i> , <i>ataxia</i> , <i>curta</i> , <i>diversa</i> , <i>douglasi</i> , <i>herbana</i> , <i>howickiana</i> , <i>karkloofia</i> , <i>lunata</i> , <i>miniseta</i> , <i>ngelensis</i> , <i>palusicola</i> , <i>sulcata</i> ;
	-	-	+	+	-	-	-	-	<i>curiosa</i> ;
3	+	+	+	-	-	-	-	-	<i>alveata</i> , <i>koilia</i> . <i>mucosa</i> , <i>silvicola</i> , <i>turneri</i> ;
	-	+	+	+	-	-	-	-	<i>liversagei</i> ;
	-	-	+	+	+	-	-	-	<i>insolita</i> ;
5	-	+	+	+	+	+	-	-	<i>melmothana</i> ;
6	-	+	+	+	+	+	+	-	<i>crassa</i> ;
7	-	+	+	+	+	+	+	+	<i>zuluensis</i> ;

The *mucosa* species-group with spermathecal pores in three intersegmental furrows has seven species: *alveata*, *koilia*, *mucosa*, *silvicola*, and *turneri* with spermathecal pores in 10/11, 11/12, 12/13, and *liversagei* with spermathecal pores in 11/12, 12/13, 13/14, and *insolita* with spermathecal pores in 13/14, 14/15, 15/16.

The *zuluensis* species-group comprises three species with spermathecal pores in five or more intersegmental furrows: *melmothana* in intersegmental furrows 11/12–15/16, *crassa* in intersegmental furrows 11/12–16/17, *zuluensis* in all, or in some of the intersegmental furrows 11/12, 12/13–15/16, 17/18.

This arrangement of species in groups according to the occurrence of spermathecal pores in intersegmental furrows is shown in Table 1. The proportionate occurrence of spermathecal pores in intersegmental furrows in all known *Tritogenia* species is shown in Table 2.

TABLE 2
The occurrence of spermathecal pores in intersegmental furrows in *Tritogenia* species, shown as percentages.

		Intersegmental furrows								%
		10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	
10/11	11/12	.....	.....	.....	.....	.....	.....	.....	.....	6.7
10/11	11/12	12/13	.....	.....	.....	.....	.....	.....	.....	16.5
	11/12	12/13	.....	.....	.....	.....	.....	.....	.....	43.5
	11/12	12/13	13/14	.....	.....	.....	.....	.....	.....	3.3
	11/12	12/13	13/14	14/15	15/16	.....	.....	.....	.....	3.3
	11/12	12/13	13/14	14/15	15/16	16/17	.....	.....	.....	3.3
	11/12	12/13	13/14	14/15	15/16	16/17	17/18	.....	.....	3.3
		12/13	.....	.....	.....	.....	.....	.....	.....	13.5
		12/13	13/14	.....	.....	.....	.....	.....	.....	3.3
			13/14	14/15	15/16	.....	.....	.....	.....	3.3

It is notable that in 90 % of all known *Tritogenia* species the spermathecal pores occur in intersegmental furrow 12/13, followed by 78 % of species with spermathecal pores in intersegmental furrow 11/12. In 73 % of species the spermathecal pores occur in two intersegmental furrows, namely 11/12, 12/13.

Key to species-groups of *Tritogenia*

The species-groups erected in this study are named after the oldest known taxon within each group, with the exception of the *grisea* species-group whose earliest described species, *benhami*, has not been rediscovered and cannot be adequately characterised yet (the true position of the single pair of spermathecal pores, in either intersegmental furrow 11/12 or 12/13, is uncertain (Michaelsen 1900 1918)); *benhami*, however, is included in this group).

- 1 Spermathecae in only one segment; spermathecal pores in 12/13 (or in 11/12) intersegmental furrow **grisea** group
- Spermathecae in more than one segment; spermathecal pores in more than one intersegmental furrow 2
- 2 Spermathecal pores in two intersegmental furrows: 10/11, 11/12, or 11/12, 12/13, or 12/13, 13/14 **sulcata** group
- Spermathecal pores in more than two intersegmental furrows 3
- 3 Spermathecal pores in three intersegmental furrows: 10/11, 11/12, 12/13, or 11/12, 12/13, 13/14, or 12/13, 13/14, 14/15 **mucosa** group
- Spermathecal pores in five or more intersegmental furrows: 11/12, 12/13, 13/14, 14/15, 15/16, or also in 16/17, 17/18 **zuluensis** group

grisea species-group

Key to species of *grisea* species-group

- 1 Spermathecal pores possibly in intersegmental furrow 11/12 or 12/13; tubercula pubertatis possibly on 17–22; male pores possibly on 19 **benhami** (Michaelsen, 1900)
- Spermathecal pores in intersegmental furrow 12/13 2
- 2 Clitellum commences on segment 13 3
- Clitellum commences on segment 15, terminates on 24; tubercula pubertatis on 1/n19–1/n23; calciferous glands dorsolateral, stalked **monosticha** sp. n.
- 3 Clitellum terminates on 22; tubercula pubertatis on 19–21; calciferous glands dorsolateral, not stalked **ngomensis** Plisko, 1992
- Clitellum terminates posterior to segment 22 4
- 4 Clitellum terminates on 24 or 25; tubercula pubertatis on 19–20; calciferous glands horseshoe-shaped, dorsally with only tiny groove, not stalked **grisea** (Michaelsen, 1902)
- Clitellum terminates on 25 or 26; tubercula pubertatis on 1/n18–1/n21,21; calciferous glands dorsolateral, widely separated ventrally, narrowly separated dorsally, not stalked **kruegeri** Plisko & Zicsi, 1991

***Tritogenia monosticha* sp. n.**

Figs 1–2

Etymology: Gr. *Mono* = one, single; *stichos* = row, rank. Refers to spermathecal pores located in only one intersegmental furrow.

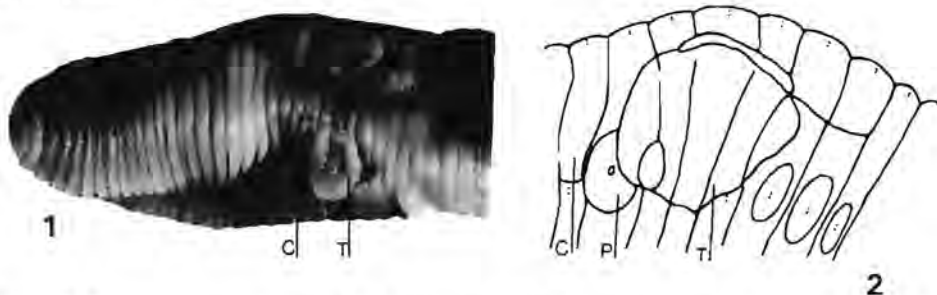
Material examined: *KwaZulu-Natal*: Holotype: clitellate NMSA/Olig.02302, 20 km E. of Melmoth (28°32'S:31°25'E), tall grasses bordering the road, from top layer of moist soil, 16 December 1995, JDP & TL.

Description based on holotype.

External characters:

General: Body cylindrical, in life plump, soft. Preserved in alcohol, slightly hardened with contracted segments. *Colour*: Not pigmented; in life grey, in alcohol yellowish-grey, the last four segments yellowish-brown. *Dimensions*: Preserved and contracted: 40 mm long, 6 mm wide at 10, 7 mm at tubercula pubertatis. *Segment number*: 79. *Prostomium*: Prolobous, lobe very small. *Segmentation*: Secondary annulation present: 1–3 simple, 1–2 with longitudinal, irregular grooves; 4–9 with two simple ringlets, first longer than second; 10 and the following segments simple; postclitellar segments randomly and irregularly annulated. *Setae*: Minute, closely paired; first pairs of *ab* on first ringlet of 7; *aa* on 11–13 slightly increasing; *ab* = *cd*, *aa* postclitellarly nearly equal to *bc*. *Nephridial pores*: Not noticeable externally. *Female pores*: Not observed. *Male pores*: Presumably in 19/20 intersegmental furrow, where there is a minute cavity between large papilla of 19 and small swelling on 20. *Spermathecal pores*: Not observed externally; in dissected specimen spermathecal necks near to 12/13 intersegmental furrow.

Clitellar region (Fig. 1): *Clitellum*: Saddle-shaped, yellowish, segmented, clearly bordered, on 15–24; on 15–18 ventrally terminating at *ab* setal lines; on 19–23 at dorsal borders of tubercula pubertatis, extending their edges on segment 24. *Tubercula pubertatis* (Fig. 2): On 1/n19–1/n23; dorsally commence much below *cd* setal lines, separated from clitellum by slender rims and narrow grooves; ventrally widely detached by entire area of *aa*; irregularly rounded, slightly longer medially than dorsally or ventrally. *Papillae*: In *ab* setal lines; small swellings on 11–13; large swellings on left side on 19, 23–25; on right side on 19, 23–24; 19 and 24 corresponding with genital glands.



Figs 1–2. *Tritogenia monosticha* sp. n. 1. Anterior part of body, ventral view with annulated preclitellar segments, clitellum and tubercula pubertatis. 2. Tuberculum pubertatis with associated papillae. [C = clitellum; P = papilla of segment 19; T = tuberculum pubertatis.]

Internal characters:

Septa: 4/5–8/9 thickened, firm; 4/5 most thickened, 5/6–8/9 moderately; 9/10 and 10/11 very thin, partly aborted; other septa delicate. *Gizzard*: Commences in posterior part of 6, extending into whole of 7; muscular. *Calciferous glands*: Dorsolateral, stalked, in 9–10. *Intestine*: Commences in 13. *Typhlosome*: Commences in area of 20 as V-shaped tube, gradually enlarging into U-shape. *Dorsal blood vessel*: Doubled in 4–11 and when crossing septa 4/5–10/11; thin tubes, close one to another in 4–7; 8–11 much enlarged, separated; single in 12 and the following segments. *Paired dorsoventral commissural vessels*: In 4–11; 5–8 thin; 9–11 thickened moniliform ‘hearts’. *Nephridia*: Small; postclitellarly two pairs per segment.

Reproductive organs: *Spermiductal funnels*: Holandric arrangement (in 10 and 11); two pairs of iridescent sperm funnels enclosed in one testis sac. *Vasa deferentia*: A pair of serpentine-shaped ducts run backwards on each side to 19, entering body wall at posterior parts of genital glands in 19/20. *Spermathecae*: 5 at each side; small, bent ampullae with long necks; in only one row, close to septa 12/13. *Seminal vesicles*: One pair in 10, extending into 11; closely connected with testis sacs. *Genital glands*: Rounded, composite, flat glands; on right side in 19 and 24, on left in 19, 23–24; in *ab* setal lines corresponding with papillae.

Biological notes: Collected from the top layer of black, organically rich soil in grassland along roadside. Associated with *Proandricus alatus* Plisko, 1996.

Distribution: Known only from the type locality, in KwaZulu-Natal.

Discussion: This species resembles *T. ngomensis* Plisko, 1992, having only one row of spermathecae, and spermathecal pores deeply embedded in the wall tissue. It differs in the number of spermathecae, shape of calciferous glands, and position of the clitellum and tubercula pubertatis.

sulcata species-groupKey to species of *sulcata* species-group

- 1 Spermathecal pores in intersegmental furrows 10/11, 11/122
- Spermathecal pores in 11/12, 12/13 or in 12/13, 13/143
- 2 Calciferous glands stalked; clitellum on 14–27,28; tubercula pubertatis on 1/n17–22**shawi** Plisko & Zicsi, 1991
- Calciferous glands dorsolateral, horseshoe-shaped, dorsally with tiny groove, not stalked; clitellum on 14–24; tubercula pubertatis on 18–22**soleata** sp. n.
- 3 Spermathecal pores in intersegmental furrows 11/12, 12/134
- Spermathecal pores in intersegmental furrows 12/13, 13/14; clitellum on 13–23,24; tubercula pubertatis on 1/n18–1/n22. Calciferous glands stalked.....**curiosa** sp. n.
- 4 Calciferous glands hemispherical, dorsolateral, clearly detached ventrally and dorsally5
- Not so11
- 5 Calciferous glands stalked.....6

- Calciferous glands not stalked.....13
- 6 Clitellum commences on segment 13.....7
- Clitellum commences on segment 14, terminates on 22; tubercula pubertatis square, on 1/n18–21**curta** Plisko & Zicsi, 1991
- 7 Clitellum terminates on segment 21; tubercula pubertatis crescentic, on 1/n18–1/n21, with no glandular field between arches**lunata** sp. n.
- Clitellum terminates posterior to segment 218
- 8 Clitellum terminates on segment 22.....9
- Clitellum terminates posterior to segment 2210
- 9 Tubercula pubertatis square, on 19–21; setae preclitellarly not converging**howickiana** (Michaelson, 1913)
- Tubercula pubertatis on 17,18–21,22; setae preclitellarly converging**sulcata** Kinberg, 1867
- 10 Clitellum terminates on segment 23; tubercula pubertatis oblong, glandular cushions, on 18–22.....**ataxia** sp. n.
- Clitellum terminates on segment 24; tubercula pubertatis rounded, rimmed cushions, on 1/n18–1/n22.....**herbana** sp. n.
- Clitellum terminate on 24,25; tubercula pubertatis nearly square, glandular cushions, on 19–22, with prominent pair of papillae on segment 21**annetteae** sp. n.
- 11 Calciferous glands horseshoe-shaped, ventrally clearly separated, dorsally with very narrow groove.....12
- Calciferous glands composed of two parts: in segment 9 soft, dorsally with tiny groove; in 10 firm, horseshoe-shaped, closely connected with oesophagus, ventrally separated moderately, dorsally with slim groove; clitellum on 13–22,23; tubercula pubertatis oval, dorsally rimmed cushions, on 1/n18,19–21, 1/n22.....**ngelensis** sp. n.
- 12 Clitellum on 13–24; tubercula pubertatis elliptical, on 1/n18–21**palusicola** sp. n.
- Clitellum on 13–23,24; tubercula pubertatis comb-shaped, oblong ridges on 1/n18–1/n22,22.....**karkloofia** Plisko & Zicsi, 1991
- 13 Clitellum on 13–23.....14
- Clitellum on 13–24; tubercula pubertatis trapezoidal, rounded at corners, on 1/n18, 19–21,22.....**douglasi** sp. n.
- 14 Tubercula pubertatis trapezoidal, rounded at corners, on 19–22; setae preclitellarly converging.....**diversa** sp. n.
- Tubercula pubertatis oval with irregular borders, on 19–22; distance between *aa* setae on segments 13–18 decreasing**miniseta** sp. n.

***Tritogenia annetteae* sp. n.**

Fig. 3

Etymology: Named for Mrs Annette Seymour-Kunz, who assisted me in collecting this species.

Material examined: *KwaZulu-Natal*: Holotype: clitellate NMSA/Olig.02335, 11 km SE. Estcourt (29°00'S:29°54'E), 2 km E. Lowlands station, 1520 m, primary grassland, from sandy, moist soil and between roots of various plants, 24 March 1988, JDP, J. G. H. Londt & A. Seymour. Paratypes collected with holotype, 5 with tubercula pubertatis, 6 juveniles, NMSA/Olig.00855.

Description based on the holotype and paratypes.

External characters:

General: Body cylindrical, soft in life, hardened after formalin preservation. *Colour*: Grey in life; preserved in formalin pinkish-grey. *Dimensions*: Preserved and contracted: Holotype 53 mm long, 4 mm wide at 10, 5 mm in region of tubercula pubertatis; paratypes (including juveniles) 11–48 mm long, 2–4 mm wide. *Segment number*: Holotype 80; paratypes: 70–81. *Prostomium*: probolous, not clearly separated from first segment. *Segmentation*: Secondary annulation present in holotype and paratypes: 1–3 simple, 1–2 with irregular longitudinal grooves; 4–8 with two simple ringlets, similar in size and appearance; 9 with two ringlets, second shorter than first; segment 10, clitellar and postclitellar segments simple. *Setae*: Minute, very closely paired; in preclitellar segments *ab* not noticeable; postclitellarly in longitudinal, even rows, in the lines above ventral edges of tubercula pubertatis; *cd* on 11, 12, 13 in line of dorsal borders of tubercula pubertatis; postclitellarly *cd* sporadically observed only on some segments, very close to *ab*. *Nephridial pores*: Not observed. *Female pores*: Minute openings in anterior part of segment 14. *Male pores*: Probably on 20, in front of papillae of 21. *Spermathecal pores*: Conspicuous externally in intersegmental furrows 11/12, 12/13; one or two small swellings.

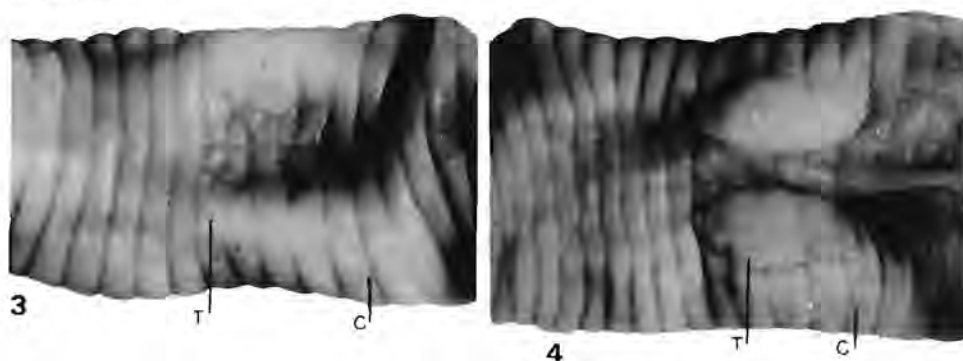
Clitellar region (Fig. 3): *Clitellum*: Saddle-shaped, segmented, whitish-grey; holotype on 13–24, dorsally extended into part of 25; ventral edges parallel to dorsal borders of tubercula pubertatis. *Tubercula pubertatis*: On 19–22; between ventral edges of clitellum and median line; ventrally very narrowly separated; nearly square glandular swellings, randomly grooved by irregular shallow furrows; with large, rounded papillae on segment 21 expanding to 20. *Papillae*: On 12 and 13 in *cd* setal lines, paired, round, small swellings with minute nipples; in ventral area of tubercula pubertatis on segment 21 extending to 20, enlarged, globular, with moderate nipples and tiny depressions.

Internal characters:

Septa: 4/5 thickened little, 5/6, 6/7 thickened moderately, not muscular, similar in thickness and appearance; 7/8, 8/9 thickened very little; 9/10 aborted; other septa in preclitellar segments thin; in posterior segments slightly thicker. *Gizzard*: Large, muscular, in 6–7; commencing abruptly in 6, extends and occupies whole of 7, terminating abruptly at septum 7/8. *Calciferous glands*: Stalked, dorsolateral; in 9–10; separated widely ventrally, by short distance dorsally; stalks commence in 9, muscular glands extend into 10. *Intestine*: Commences in 14. *Typhlosole*: Commences in 17, slim, V-shaped; in the following segments gradually enlarging, square and medially furrowed; terminates in area of 52. *Dorsal blood vessel*: Double in 4–11; double also when crossing septa 4/5–10/11; in 12 slightly enlarged, single; in following segments single. *Paired dorsoventral commissural vessels*: In 4–8 thin,

gradually enlarging tubes; in 9–11 thick, moniliform 'hearts'. *Nephridia*: In posterior segments two small pairs: ventral pairs close to median body line, dorsolateral pairs dorsally.

Reproductive organs: *Spermiductal funnels*: Holandric arrangement (in 10 and 11); two pairs of funnels, of similar size and appearance, enclosed in separate sacs, connected with vesiculae seminales; in dissected holotype sperm observed in both funnels. *Seminal vesicles*: Two pairs of small sacs, linked with testis sacs; in 10 and 11. *Spermathecae*: Moderate in size, irregular in shape, with long necks; close to genital glands of segments 12 and 13, near septa 11/12, 12/13; in holotype anteriorly one pair per segment, posteriorly two pairs at left side, one ampulla at right; in dissected paratype two spermathecae at each side in both segments. *Ovaries*: In 13; large, funnel-like. *Genital glands*: Associated with papillae; paired, large, finger-shaped, elongated structures; in segments 12 and 13 three-branched, in 21 four-branched.



Figs 3–4. *Tritogenia* species, clitellar region, ventral view. 3. *T. annetteae* sp. n. 4. *T. ataxia* sp. n. [C = clitellum; T = tuberculum pubertatis.]

Biological notes: Found in the upper layer of moderately moist soil between roots of various plants. Juvenile and semi-mature specimens were numerous, but there was only one clitellate specimen and a few with tubercula pubertatis. The numerous juveniles found, and the sperm observed in spermiductal funnels and spermathecae, confirm breeding activity during early summer.

Distribution: Known only from the type locality in the midlands of KwaZulu-Natal.

Discussion: Most similar to *ataxia* sp. n. They have in common the location of spermathecal pores, irregular arrangement of setae, position of the clitellum and finger-shaped genital glands. They differ in the position and shape of the tubercula pubertatis, and the number and position of genital papillae.

***Tritogenia ataxia* sp. n.**

Fig. 4

Etymology: *G. ataxia* = disorder, confusion. Refers to the arrangement of setae.

Material examined: *KwaZulu-Natal*: Holotype: clitellate NMSA/Olig.02062, at border of Pongola Nature Reserve (27°25'S:31°02'E), grassland, from moist soil, dug

by shovel, 19 January 1995, JDP & BRS. Paratypes: collected near type locality, 19 January 1995, JDP, BRS, B. Howells: 1 with tubercula pubertatis, 1 juvenile NMSA/Olig.02065, 2 juveniles NMSA/Olig.02077. *Mpumalanga*: 31 km NE. Carolina (26°04'S:30°07'E) from dry bed of Buffel River in primary grassland, from dry soil, 4 December 1992, JDP & BRS, 1 clitellate NMSA/Olig.02329, same locality in anabiotic state 2 clitellate, 5 juveniles NMSA/Olig.01840; 30 km NE. Machadodorp (25°40'S:30°15'E) from dry bed of stream, dry, sandy soil, 6 December 1995, JDP & TL, 2 clitellate, 4 juveniles NMSA/Olig.02223; Genezareth Camp near Lake Chrissie (26°18'S:30°13'E), from moist soil of undisturbed ground close to lake, 5 December 1995, JDP & TL, 1 specimen NMSA/Olig.02209. Other material: *Mpumalanga*: 5 km E. Carolina (26°04'S:30°07'E), from burnt grassland, moist, sandy soil, 6 December 1995, JDP & TL, 5 with tubercula pubertatis, 6 juveniles NMSA/Olig.02219; Genezareth Camp near Lake Chrissie (26°18'S:30°13'E), from moist soil of fallow ground close to lake, 5 December 1995, JDP & TL, 6 clitellate, 4 juveniles NMSA/Olig.02210.

Description based on the holotype and paratypes.

External characters:

General: Body cylindrical, firm in life, softened after preservation. *Colour*: Grey in life; preserved whitish-grey. *Dimensions*: Preserved and contracted: Holotype 60 mm long, 5 mm wide at 10, 6 mm in region of tubercula pubertatis; paratypes: semi-mature 45–62 mm long, 5–8 mm wide at tubercula pubertatis; juveniles 15–40 mm long, 3 mm wide. *Segment number*: Holotype 89; paratypes 74–88. *Prostomium*: Prolobous, small. *Segmentation*: Secondary annulation present in holotype and paratypes: 1–3 simple, 1–2 with irregular longitudinal grooves; 4–8 with two simple ringlets, similar in size and appearance; 9 with two ringlets, second shorter than first; 10, clitellar and postclitellar segments simple, irregularly annulated. *Setae*: Minute, paired in unusual arrangement. On clitellate holotype: first pairs of probably lateral setae *cd* on first ringlet of 7; the following pairs on first ringlets of segments 8–9, and on 10–17 slightly above lines of ventral edges of clitellum; on segments occupied by tubercula pubertatis and the posterior part of clitellum, setae were not observed. On paratypes: *ab* preclitellarly slightly converging. On majority of specimens: postclitellarly *ab* = *cd*, *aa* > *bc*, *dd* > 1/2 *u*; rows *ab* and *cd* in irregular, uneven lines, with short distance between each row. On juvenile paratypes: probably lateral pairs clearly noticeable on first ringlets of segments 8–9 and 10–18; ventral pairs commence on 19 and extend on following segments to 1/3 of body length, in even lines, posteriorly in irregular pairs; *cd* pairs hardly noticeable, in irregular lines. On other paratypes: setal arrangement differs slightly, being however, similar and obscure. *Nephridial pores*: Not observed. *Female pores*: Minute openings in posterior part of segment 14, close to 14/15 intersegmental furrow, in line of ventral edges of clitellum. *Male pores*: Probably in intersegmental furrow 19/20, on tubercula pubertatis, where there are small depressions. *Spermathecal pores*: Conspicuous externally in intersegmental furrows 11/12, 12/13.

Clitellar region (Fig. 4): *Clitellum*: Saddle-shaped, whitish-grey, segmented; clearly bordered anteriorly and posteriorly; ventrally bordered above *ab* setal lines;

holotype on 13–23; paratypes on 13,14–23,24. *Tubercula pubertatis*: Oblong trapeziform, rounded at corners, on 1/n18–1/n22; usually commencing at 3/4 of segment 18, extending near intersegmental furrow 22/23; dorsally they commence below *cd* setal lines, and ventrally terminate below *ab* setal lines; medially broadly detached; on some paratypes at ventral, posterior corners on 22 is a large, single papilla. *Papillae*: Paired or single, small swellings in *ab* or *cd* setal lines, on 11–17, 22, 26, or larger swellings on 12, 22, 26.

Internal characters:

Septa: 4/5 thickened little, 5/6, 6/7 thickened moderately, similar in thickness and appearance; 7/8, 8/9 less thickened; 9/10 aborted; other septa thin. *Gizzard*: Large, muscular, in 6–7; commencing in 6, extends and occupies whole of 7, terminating abruptly at septum 7/8. *Calciferous glands*: One pair stalked, dorsolateral, in 9–10; each gland connected with oesophagus by soft stalk in 9; muscular glands in 10. *Intestine*: Commences in 13. *Typhlosole*: In holotype commences as V-shaped in 17, somewhat enlarging in the following segments, terminates in area of 48. *Dorsal blood vessel*: Double in 4–11; double also when crossing septa 4/5–10/11; single in 12 and the following segments. *Paired dorsoventral commissural vessels*: In 4–8 thin, gradually enlarging tubes; in 9–11 thick, moniliform ‘hearts’. *Nephridia*: In posterior segments two small pairs: ventral pairs close to median body line, lateral pairs dorsal; in preclitellar segments nephridia larger than those from posterior segments.

Reproductive organs: *Spermiductal funnels*: Holandric arrangement (in 10 and 11); two pairs of funnels, similar size and appearance, enclosed in sacs, connected with vesiculae seminales. *Seminal vesicles*: Two pairs of small sacs, linked with testis sacs; in 10 and 11. *Spermathecae*: Small ampullae with very long necks, close to septa 11/12, 12/13; one or two at each side. *Ovaries*: In 13; large, funnel-like, near septa 13/14, close to median line. *Genital glands*: In segment 12 single, four-branched, finger-shaped glands; in some paratypes also in 22, 26 small, flat structures.

Biological notes: Found in sandy grassland soils, dry river beds, and in the vicinity of Lake Chrissie. Occurs in the top 1–20 cm of soil between roots. The holotype was found in grassland, in close proximity to indigenous forest, also with introduced trees and shrubs. Searches inside the forest produced no specimens.

All specimens collected on the bank of the dry bed of the Buffel River were in anabiotic state, with the intestine filled with liquid, and lacking soil particles. However, sperm was found in spermiductal funnels and in spermathecae in all dissected clitellate specimens. Juveniles were very small, one of them freshly emerged from the cocoon. This observation suggests that adults were sexually active before the anabiotic state.

Individuals gathered from very dry, sandy soil on the bank of a dry stream near Machadodorp were active, although seemingly in unfavourable conditions.

Distribution: In north-eastern parts of South Africa. Found close to Pongola Nature Reserve in northern KwaZulu-Natal, and at a few localities in Mpumalanga.

Discussion: Characterised by the possession of spermathecal pores in two intersegmental furrows 11/12, 12/13, and the irregular arrangement of setae. It

resembles *annetteae*, but they differ in the position of the clitellum and the shape of tubercula pubertatis.

***Tritogenia curiosa* sp. n.**

Figs 5–6

Etymology: *L. curiosus* = curious, strange. Refers to the position of the spermathecae.

Material examined: *KwaZulu-Natal*: Holotype: clitellate NMSA/Olig.02326, Entumeni Nature Reserve (28°53'S:31°19'E), indigenous forest *ca.* 1 km from tourist camp, in top layer of moist soil, 1 February 1989, JDP & BRS. Paratypes: collected with holotype: 5 mature, 6 juveniles NMSA/Olig.00338; 1 clitellate NMSA/Olig.00718.

Description based on holotype and paratypes.

External characters:

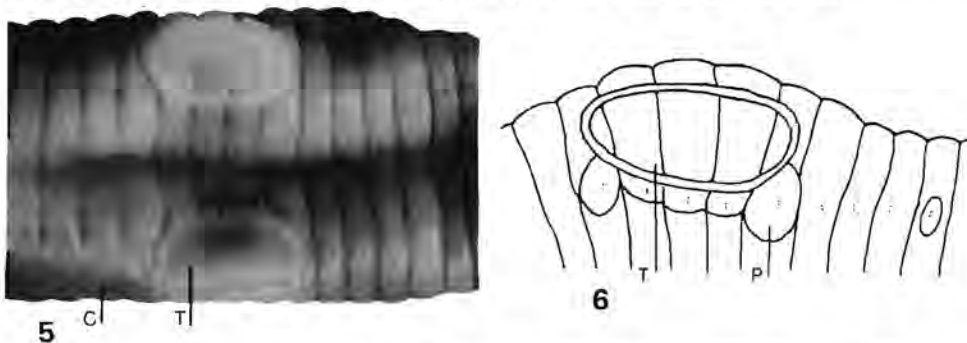
General: Body in life soft. Preserved hardened, with contracted segments. **Colour:** In life whitish-grey. Preserved: in middle of body yellowish-grey, ends of body brownish.

Dimensions: Preserved and contracted: Holotype 55 mm long, 7 mm wide at 10, 8 mm at tubercula pubertatis; paratypes 30–40 mm long. **Segment number:** Holotype 89; paratypes 88–96. **Prostomium:** Prolobous. **Segmentation:** 1–3 simple, 1–2 with longitudinal grooves; 4–8 with two simple ringlets, similar in size and appearance; 9

with two ringlets, second ringlet shorter than first; 10 and the following segments simple, randomly annulated. **Setae:** Closely paired; *ab* easily seen, *cd* only under high magnification; first pairs of *ab* on first ringlet of 6; *ab* = *cd*; postclitellarly *aa* > *bc*.

Female pores: On 14 above *ab* setal lines. **Male pores:** Probably in 18/19, in small invaginations. **Spermathecal pores:** In intersegmental furrows 12/13 13/14.

Clitellar region (Fig. 5): **Clitellum:** Saddle-shaped; holotype 13–23; paratypes 13–23, 24. **Tubercula pubertatis** (Fig. 6): On 1/n18–1/n22; rounded trapeziform cushions, much shorter ventrally; glandular, segmented; with narrow rims; ventrally extend to *ab* setal lines; on 18 and 22 shorter, stretching only slightly above *ab*; separated one from another by wide, segmented field. **Papillae:** Paired swellings; on 18 and 22 large, glandular, very close to tubercula pubertatis; on 26 moderate; on 19–21 small, enveloping tubercula pubertatis; on some paratypes only single papilla on 28.



Figs 5–6. *Tritogenia curiosa* sp. n. 5. Clitellar region, ventral view. 6. Tuberculum pubertatis. [P = papilla; T = tuberculum pubertatis.]

Internal characters:

Septa: 4/5–6/7 thickened very much; 7/8 and 8/9 thin, strong; 9/10 very thin, partly aborted; other septa postclitellarly strong. *Gizzard*: In 6–7, with only small portion in 6; large, muscular. *Calciferous glands*: In 9–10, dorsolateral; stalked. *Intestine*: Commences in 13. *Typhlosole*: In dissected paratype commences in area of 22, terminates in 52. *Dorsal blood vessel*: Doubled in 4–11 and when crossing septa 4/5–10/11; in 4–7 thin tubes, in 8–12 enlarged. *Paired dorsoventral commissural vessels*: 4–8 thin tubes, 9–11 enlarged, moniliform ‘hearts’. *Nephridia*: Two pairs per segment.

Reproductive organs: *Spermiductal funnels*: Holandric arrangement (in 10 and 11); enclosed in testis sacs. *Spermathecae*: Tube-like, bent, near septa 12/13 and 13/14; in holotype: one pair in 12/13, in 13/14 on left side one ampulla, on right three; in dissected paratype: four pairs in each segment. *Seminal vesicles*: Small sacs, in 10 and extending to 11; closely attached to testis sacs. *Genital glands*: In 18 and 26; large, divided into small sections by narrow grooves, flat; containing genital setae.

Biological notes: Collected in summer, after rainy days, from the soil of indigenous forest located on slopes at ca. 520–600 m. Specimens were found in upper soil, under a thin layer of litter. They were associated with *Proandricus entumeni* Plisko, 1992.

Distribution: Known only from the type locality in north-eastern KwaZulu-Natal.

Discussion: A distinctive species with spermathecal pores in intersegmental furrows 12/13, 13/14.

***Tritogenia diversa* sp. n.**

Fig. 7

Etymology: *L. diversus* = different. Refers to the arrangement of setae.

Material examined: *KwaZulu-Natal*: Holotype: specimen with well-developed tubercula pubertatis, and partly developed clitellum, NMSA/Olig.02092, Babanango (28°23'S:31°05'E), near dry stream, grassland, dry soil at depth of ca. 30 cm, 22 January 1995, JDP & BRS. Other material: *KwaZulu-Natal*: near Babanango village, grassland, dry soil, 1 juvenile probably recently out of cocoon, 22 January 1995, JDP & BRS, NMSA/Olig.02087.

Description based on holotype.

External characters:

General: Body in life firm. Preserved softened. *Colour*: In life whitish-grey. Preserved grey. *Dimensions*: Holotype preserved and contracted 40 mm long, 4 mm wide at tubercula pubertatis. *Segment number*: Holotype 106. *Prostomium*: Prolobous. *Segmentation*: 1–3 simple, 1–2 with longitudinal grooves; 4–8 with two simple ringlets, similar in size and appearance; 9 with two ringlets, second ringlet shorter than first; 10 and the following simple, randomly annulated. *Setae*: Closely paired; first pairs of *ab* on first ringlet of 8; preclitellarly converging, with median ventral distance diminishing; on 19–22 at edges of ventral borders of tubercula pubertatis; first pairs of *cd* on 22, with small papillae; the following with no papillae; postclitellarly *aa* > *bc*, *dd* < 1/2 u. *Female pores*: On 14 above *ab* setal lines. *Male*

pores: Probably in 18/19, in small invaginations, close to genital setae of 19. *Spermathecal pores*: In intersegmental furrows 11/12, 12/13.

Clitellar region (Fig. 7): *Clitellum*: Not fully developed, saddle-shaped; on 13–23. *Tubercula pubertatis*: trapezoidal, glandular cushions rounded at corners; on 19–22; separated from clitellum by narrow furrows and rims; ventrally extending to *ab* setal lines; anteriorly separated one from another by narrow distance, broadened posteriorly. *Papillae*: Paired swellings; on 12, 13, 14 and 23, glandular.

Internal characters:

Septa: 4/5 thickened very little, 6/7, 7/8 thickened moderately; 7/8 and 8/9 thin, strong; 9/10 aborted; other septa postclitellarly thin. *Gizzard*: In 6–7; muscular. *Calciferous glands*: Not stalked; in 9–10; dorsolateral; ventrally separated widely, dorsally with short distance. *Intestine*: Commences in 13. *Typhlosole*: Commences in 17. *Dorsal blood vessel*: Doubled in 4–11 and when crossing septa 4/5–10/11; in 4–7 thin tubes, in 8–11 enlarged. *Paired dorsoventral commissural vessels*: 4–8 thin tubes, 9–11 enlarged, moniliform ‘hearts’. *Nephridia*: Two small pairs per segment.

Reproductive organs: *Spermiductal funnels*: Holandric arrangement (in 10 and 11); enclosed in testis sacs. *Spermathecae*: Tube-like ampullae, various shapes, near septa 11/12 and 12/13; 3 pairs per segment. *Seminal vesicles*: Moderately sized sacs, in 10 and 11; closely attached to testis sacs. *Genital glands*: Minute glands in 19, consisting of very small genital setae.

Biological notes: Collected in summer, from dry, grassland soil, at a depth of *ca.* 30 cm. Associated with *Proandricus babanango* Plisko, 1992.

Distribution: Known only from the type locality, in the northern part of KwaZulu-Natal.

Discussion: Most similar to *miniseta* sp. n. Both are characterised by spermathecal pores in two intersegmental furrows (11/12, 12/13), and irregular arrangement of setae, but differ in the shape of the tubercula pubertatis, and the number and position of papillae.

***Tritogenia douglasi* sp. n.**

Fig. 8

Etymology: Named for Mr Douglas Harebottle, who collected and donated this species to the Natal Museum.

Material examined: *KwaZulu-Natal*: Holotype: clitellate NMSA/Olig.01950, Dlinza Forest (29°53'S:31°28'E), indigenous, mixed forest, B.11, February 1992, collected using formalin solution by D. Harebottle. Paratypes: collected from same locality: 1 clitellate and 14 juvenile, November 1991, NMSA/Olig.01937; 1 clitellate, 9 July 1991, NMSA/Olig.01909.

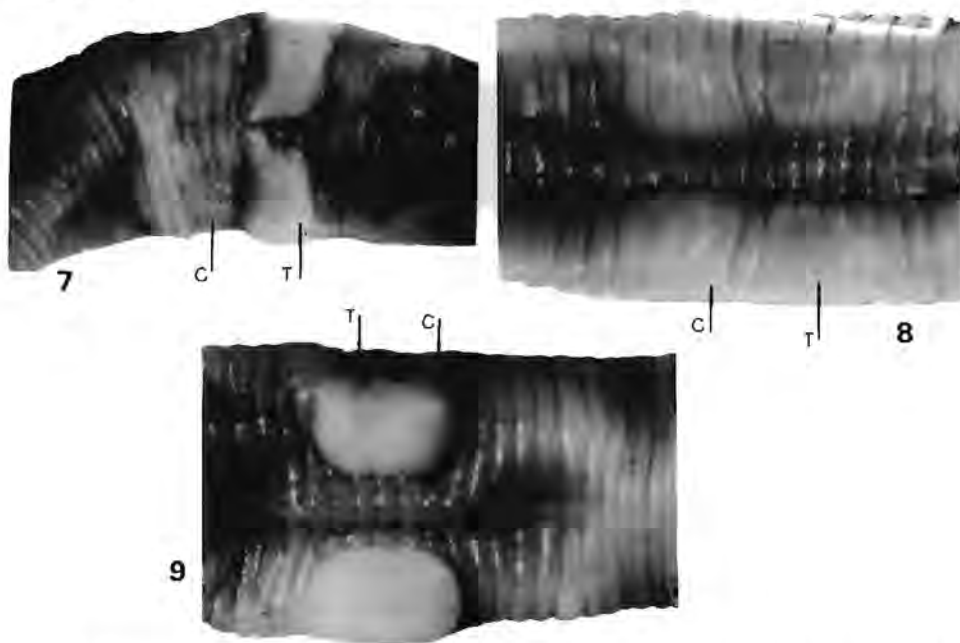
Description based on holotype and paratypes.

External characters:

General: Body cylindrical, soft in life. *Colour*: Preserved dark grey. *Dimensions*: Preserved and contracted: holotype 65 mm long, 5 mm wide at 10, 7 mm in region of

tubercula pubertatis; clitellate paratypes: 61–64 mm long, 7 mm wide at tubercula pubertatis. *Segment number*: Holotype 85; paratypes 78–92. *Prostomium*: Prolobous, small. *Segmentation*: Secondary annulation present in holotype and paratypes: 1–3 simple, 1–2 with irregular longitudinal grooves; 4–9 with 2 simple ringlets, similar in size and appearance; 10 and the following segments simple; clitellar segments dorsally simple, ventrally irregularly annulated; postclitellar segments simple, randomly annulated. *Setae*: Minute, closely paired; first pairs of *ab* noticeable on holotype on 4, on paratypes on 5 or 7; *cd* much smaller than *ab*, observed on only a few postclitellar segments. *Nephridial pores*: Not observed. *Female pores*: On 14, large openings on posterior portion of segment, in dorsal lines of tubercula pubertatis. *Male pores*: In 17/18 intersegmental furrow, at anterior edges of tubercula pubertatis. *Spermathecal pores*: In intersegmental furrows 11/12, 12/13; clear, minute openings, ventrally.

Clitellar region (Fig. 8): *Clitellum*: Saddle-shaped, segmented, whitish-grey; holotype and most paratypes on 13–24; on one paratype anteriorly partly on 12; ventral borders terminate parallel to dorsal edges of tubercula pubertatis. *Tubercula pubertatis*: On 1/n18, 19–21, 1/n22; commence below clitellar edges, extending to *ab* setal lines; glandular, trapezoidal with rounded corners, dorsally longer than ventrally; with clear intersegmental furrows and narrow rims. *Papillae*: Paired or single, small swellings in *ab* setal lines, on all or some of segments 14–17, 22, 26.



Figs 7–9. *Tritogenia* species, clitellar region, ventral view. 7. *T. diversa* sp. n. 8. *T. douglasi* sp. n. 9. *T. herbana* sp. n. [C = clitellum; T = tuberculum pubertatis.]

Internal characters:

Septa: 4/5 thickened moderately; 5/6–8/9 much thickened, similar in appearance; other septa in preclitellar segments very thin; in posterior segments slightly stronger.

Gizzard: Large, commencing abruptly in posterior part of 6, extends and occupies whole of 7, terminating at septum 7/8. *Calciferous glands*: One pair, not stalked, muscular, in 9–10; each gland closely connected with oesophagus; ventrally widely separated, dorsally by short distance. *Intestine*: Commences abruptly in 13. *Typhlosole*: Commences gradually as V-shaped in area of 20, terminates in holotype in 51, in dissected paratype in 53. *Dorsal blood vessel*: Double in 4–11 and also when crossing septa 4/5–10/11; in 12 and the following segments single. *Paired dorsoventral commissural vessels*: In 4–8 slender tubes; in 9–11 thick, moniliform ‘hearts’. *Nephridia*: In posterior segments two small pairs; dorsal pairs with long, thin tubes; ventral pairs close to median body line, with shorter tubes; in preclitellar segments nephridia much larger than those from posterior segments.

Reproductive organs: *Spermiductal funnels*: Holandric arrangement (in 10 and 11); two pairs of funnels, similar in appearance; enclosed in separated sacs, connected very closely with vesiculae seminales; in all dissected specimens sperm observed in both funnels. *Seminal vesicles*: Two pairs of moderately sized sacs, linked with testis sacs; in 10 and 11. *Spermathecae*: Minute, slender, bent or serpentine, tube-like, close to septa 11/12, 12/13; one, two or three ampullae at each side. *Ovaries*: In 13; large, funnel-like near septa 13/14. *Genital glands*: Flat glands, associated with papillae and *ab* setae, in 15 or 16 and 22; each gland comprises 3–4, oval or half-oval structures.

Biological notes: Collected on the soil surface after ground was flooded with 1 % formalin solution. Specimens emerged immediately after formalin penetrated the soil, suggesting occupation of the top layer. Clitellate specimens were found in July (dry season), November (at the beginning of the rainy season) and in February (end of the rainy season). The large number of juveniles collected in November, suggests sexual activity in early spring or even possibly in the dry season.

Distribution: Known only from the Dlinza Forest on the SW. side of Eshowe in KwaZulu-Natal. This small, protected area of ca. 205 ha of scarp forest, categorised as one of the Entumeni Forests by Cooper (1985), is located at about 520–600 m.

Discussion: Most similar to the new species *palusicola*. Both have spermathecal pores in intersegmental furrows 11/12 12/13, and the tubercula pubertatis on 1/n18–1/n22. They differ in the shape of the tubercula pubertatis and the calciferous glands.

***Tritogenia herbana* sp. n.**

Fig. 9

Etymology: *L. herba* = green vegetation. Refers to the biotope.

Material examined: *KwaZulu-Natal*: Holotype: clitellate NMSA/Olig.02337, 40 km S. Vryheid (27°46'S:30°50'E), grassland, from moist soil, 16 December 1995, JDP & TL. Paratypes: collected with holotype: 1 with tubercula pubertatis, 2 juveniles, NMSA/Olig.02299. Other material: *Mpumalanga*: 30 km N. Lydenburg (25°06'S:30°27'E) under tall grass near road, 6 December 1995, JDP & TL, 1 specimen with tubercula pubertatis, 1 juvenile, NMSA/Olig.02231.

Description based on holotype and paratypes.

External characters:

General: Body cylindrical, firm in life, softened after preservation. *Colour:* Grey in life; preserved whitish-grey. *Dimensions:* Preserved and contracted: Holotype 50 mm long, 6 mm wide at 10, 7 in region of tubercula pubertatis; paratypes: semi-mature 55 mm long, 7 mm wide at tubercula pubertatis; juveniles 25–35 mm long, 3 mm wide. *Segment number:* Holotype 74; paratypes 83–88. *Prostomium:* Prolobous, large. *Segmentation:* Secondary annulation present in holotype and paratypes: 1–3 simple, 1–2 with irregular longitudinal grooves; 4–8 with 2 simple ringlets, similar in size and appearance; 9 with 2 ringlets, second shorter than first; 10, clitellar and postclitellar segments simple, randomly and irregularly annulated. *Setae:* Minute, closely paired; first pairs of *ab* on first ringlet of 8; the following pair on the first ringlet of segment 9; on segments 10–17 *ab* above lines of ventral edges of tubercula pubertatis; on segments occupied by tubercula pubertatis setae not observed; postclitellarly *aa* > *cd*, *ab* = *cd*, *dd* < 1/2 u; posteriorly *ab* and *cd* in longitudinal, uneven rows. *Nephridial pores:* Not observed. *Female pores:* Minute openings in median part of segment 14, in *ab* setal lines. *Male pores:* Not seen; probably in intersegmental furrow 19/20, on tubercula pubertatis, where there are small depressions. *Spermathecal pores:* Clearly evident externally in intersegmental furrows 11/12, 12/13.

Clitellar region (Fig. 9): *Clitellum:* Saddle-shaped, segmented, whitish-grey; holotype 13–24. *Tubercula pubertatis:* On 18–1/n22, oval-shaped, glandular swellings; separated from clitellum by thick rims; dorsally commence below *bc* setal lines, extending to 1/4 of space between *aa*; ventrally broadly separated. *Papillae:* On holotype and semi-mature paratype, paired small swellings in *ab* setal lines, on 12; the other pairs observed on not fully mature specimens as minute swellings on 22 are probably covered by thick, glandular tissue of tubercula pubertatis.

Internal characters:

Septa: 4/5 thickened slightly; 5/6, 6/7 thickened moderately, similar in thickness and appearance; 7/8, 8/9 thickened less than 5/6; 9/10 aborted; other septa thin. *Gizzard:* Moderate, muscular, in 6–7; commencing in 6, extends into 7, terminating in posterior part of segment 7. *Calciferous glands:* Stalked, dorsolateral; in 9–10; each gland connected with oesophagus by short stalk in 9; muscular glands extend into 10. *Intestine:* Commences in 13. *Typhlosole:* In holotype commences as thin, V-shaped in 18, gradually enlarging in the following segments, terminating in area of 50. *Dorsal blood vessel:* Double in 4–11; double also when crossing septa 4/5–10/11; in 12 and the following segments single. *Paired dorsoventral commissural vessels:* In 4–8 thin, gradually enlarging tubes; in 9–11 thick, moniliform 'hearts'. *Nephridia:* Small, close to median body line; in posterior segments irregular pairs, smaller than those from anterior segments.

Reproductive organs: *Spermiductal funnels:* Holandric arrangement (in 10 and 11); two pairs of funnels, small, enclosed in testis sacs connected with vesiculae seminales. *Seminal vesicles:* Two pairs of small sacs, linked with testis sacs; in 10 and 11. *Spermathecae:* moderately sized ampullae with very long necks, close to septa 11/12, 12/13; two pairs in segment in front of genital gland of 12, three in posterior segment. *Ovaries:* In 13; large, funnel-like, near septa 13/14, close to

median spermathecae of posterior pair. *Genital glands*: In segment 12 a pair, four-branched, moderate in size, flat, round, not finger-shaped glands; in 18–23 small, round, flat; in 24 small, four-branched, flat, with genital papillae.

Biological notes: Found in moist, sandy, grassland soil, near a road, in the top 20 cm, between grass-roots. One specimen shows an abnormality in the position of its well-developed tubercula pubertatis: the right tuberculum is on segments 18–21, the left on 18–22; both tuberculae are well developed, and spermathecae in this specimen are in the normal position for this species.

Distribution: Known from the type locality near Vryheid, in northern KwaZulu-Natal, and from northern Mpumalanga.

Discussion: Similar to *ataxia* sp. n., sharing the characters of the location of spermathecal pores and irregular arrangement of setae. They differ in the position and shape of the clitellum and the tubercula pubertatis.

***Tritogenia lunata* sp. n.**

Figs 10–12

Etymology: *L. lunatus* = crescent-shaped. Refers to the shape of the tubercula pubertatis.

Material examined: *KwaZulu-Natal*: Holotype: clitellate NMSA/Olig.02331, Karkloof, Mr Geekie's Farm 'Benvie' (29°18'S:30°13'E), lower Afromontane forest at ca. 1260 m, from first 20 cm of moist soil under thick litter, 22 February 1989, JDP & BRS. Paratypes: collected with holotype, 8 clitellate, 12 with tubercula pubertatis, 27 juveniles, NMSA/Olig.0242; other material collected with holotype and paratypes: 2 juveniles removed from cocoon and preserved immediately, NMSA/OLIG.02332; 1 removed from cocoon and kept for seven days in the soil, NMSA/OLIG.02333.

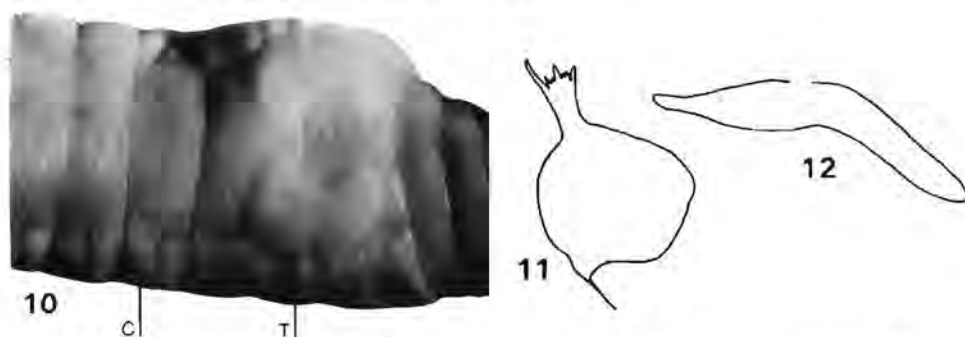
Description based on holotype and paratypes.

External characters:

General: Body cylindrical, soft in life, hardened after formalin preservation. *Colour*: Grey in life; preserved whitish-grey. *Dimensions*: Preserved and contracted: Holotype 78 mm long, 6 mm wide at 10, 7 in region of tubercula pubertatis; clitellate paratypes: 58–83 mm long, 4–6 mm wide at tubercula pubertatis; juvenile 27–58 mm long, 2–4 mm wide. *Segment number*: Holotype 92 (the last 16 segments regenerated); paratypes: clitellate 73–92; juveniles 72–84. *Prostomium*: Prolobous, small. *Segmentation*: Secondary annulation present in holotype and paratypes: 1–3 simple, 1–2 with irregular longitudinal grooves; 4–9 with 2 simple ringlets, similar in size and appearance; 10, clitellar and postclitellar segments simple, randomly irregularly annulated. *Setae*: Minute, paired; first pairs of *ab* on 9, *cd* on 10; the following pairs of *ab* and *cd* as from 11 to 18 gradually converge towards median line, diminishing median-ventral distance between *aa* setal lines, on segments 14–17 becoming much closer than on segments 10–13; in anterior part of clitellar region *ab* run below ventral edges of clitellum; on segments covered by tubercula pubertatis at ventral edges of crescent shapes; postclitellarly *aa* > *bc*, *ab* = *cd*, running in even rows. *Nephridial pores*: Not observed. *Female pores*: Minute openings in posterior

part of segment 14, near median line. *Male pores*: Not detected externally; probably in 19/20 intersegmental furrow, where there are small depressions. *Spermathecal pores*: Clearly noticeable externally in intersegmental furrows 11/12, 12/13; one or two small swellings.

Clitellar region (Fig. 10): *Clitellum*: Saddle-shaped, segmented, whitish-grey; in holotype and majority of paratypes on 14–21; only on one paratype partly on 13, 14–21; ventral edges parallel with *cd* setal lines and dorsal borders of tubercula pubertatis. *Tubercula pubertatis*: Crescent-shaped; on 19–1/n21, expanding partially on 1/n18; commences below clitellar edges, extending to *ab* setal lines; glandular swellings, randomly grooved by irregular shallow notches; ventrally separated by non-glandular field. *Papillae*: Paired or single, small swellings in *ab* and *cd* setal lines, on all or some of segments 12, 17, 22, 23.



Figs 10–12. *Trinogenia lunata* sp. n. 10. Clitellar region, ventral view. 11. Cocoon. 12. Juvenile specimen (one of three) extracted from a nearly mature cocoon. [C = clitellum; T = tuberculum pubertatis.]

Internal characters:

Septa: 4/5, 5/6, 6/7 thickened very much, similar in thickness and appearance; 7/8, 8/9 thickened moderately, strong; 9/10 aborted; other septa in preclitellar segments very thin; in posterior segments slightly stronger. *Gizzard*: Large, muscular, in 6–7; commencing abruptly in posterior part of 6, extends into and occupies whole of 7, terminating abruptly at septum 7/8. *Calciferous glands*: In 9–10; stalked, dorsolateral; widely separated ventrally, with short distance dorsally; each muscular gland connected with oesophagus by soft stalk in 9; muscular parts occur partially in 9, projecting into 10, where short vessels, expanding from enlarged dorsoventral commissural vessels of 10, enter into top of muscular gland. *Intestine*: Commences in 13. *Typhlosole*: Commences as V-shaped in 17, and gradually enlarges into thick, U-shaped tube; terminates in area of 45. *Dorsal blood vessel*: Double in 4–11; double also when crossing septa 4/5–10/11; in 12 and the following segments single. *Paired dorsoventral commissural vessels*: In 4–8 thin, gradually enlarging tubes; in 9–11 thick, moniliform 'hearts'. *Nephridia*: In posterior segments two small pairs: ventral close to median body line, lateral slightly above *cd* setal lines; in preclitellar segments nephridia much larger than those from posterior segments.

Reproductive organs: *Spermiductal funnels*: Holandric arrangement (in 10 and 11); two pairs of funnels, similar size and appearance, enclosed in separated sacs,

connected with vesiculae seminales; in all dissected specimens sperm was observed in both funnels. *Seminal vesicles*: Two pairs of moderately sized sacs, linked with testis sacs; in 10 and 11. *Spermathecae*: Tube-like ampullae, with long necks, near genital glands of segment 12; close to septa 11/12, 12/13; in holotype and one dissected paratype: anteriorly one pair per segment, posteriorly two pairs at each side. *Ovaries*: In 13; large, funnel-like, near septa 13/14, close to median line. *Genital glands*: In segment 12 one pair of four-branched, finger-shaped glands; in 19, 20, 21 moderate in size, flat, composed of 3–4 oval or half-oval structures.

Biological notes: Found in moderately moist soil of indigenous forest, close to small stream. Mixed *Podocarpus* with thick bush, herbage and a thick layer of litter characterises this type of forest. Juveniles were collected in large numbers from the top layer of soil, under a thick blanket of litter. Mature specimens occurred closer to the stream, in much moister soil. When alive, they were clumsy with slow movements; disturbed specimens contracted the preclitellar segments rapidly.

In all dissected clitellate specimens sperm was observed in the spermiductal funnels and spermathecae, confirming breeding activity during summer. From a nearly mature cocoon (Fig. 11) *ca.* 4 mm long, 5 mm wide, three juveniles 10.0–10.2 mm long, 1 mm wide (Fig. 12) were extracted.

Distribution: Known only from the afromontane Karkloof Forest in KwaZulu-Natal.

Discussion: Most similar to *sulcata* Kinberg, 1867. The location of spermathecal pores, and convergence of setae on preclitellar segments, occurs in both species. They differ in the position of the clitellum and the shape of the tubercula pubertatis.

***Tritogenia miniseta* sp. n.**

Fig. 13

Etymology: *L. minus* = minute; *seta* = seta, bristle. Refers to the minute setae.

Material examined: *KwaZulu-Natal*: Holotype: clitellate NMSA/Olig.02370, Itala Game Reserve, near Simongweni (27°35'S:31°13'E), marshy grassland, from moist soil, 26 November 1993, JDP, TL & DMcC. Paratype: collected with holotype, 2 semi-mature, NMSA/Olig.01761.

Description based on holotype and paratypes.

External characters:

General: Body cylindrical, firm in life, softened after preservation. **Colour**: Grey in life; preserved whitish -grey. **Dimensions**: Preserved and contracted: Holotype 38 mm long, 5 mm wide at 10, 7 in region of tubercula pubertatis; paratypes: 37–39 mm long, 5 mm wide. **Segment number**: Holotype 89; paratypes 88–89. **Prostomium**: Prolobous, small. **Segmentation**: Secondary annulation present in holotype and paratypes: 1–3 simple, 1–2 with irregular longitudinal grooves; 4–8 with 2 simple ringlets, similar in size and appearance; 9 with 2 ringlets, second shorter than first; 10, clitellar and postclitellar simple, randomly and irregularly annulated. **Setae**: Minute; first pairs of *ab* on first ringlet of 8, not closely paired; the following pairs on first ringlet of 9 similarly spaced; *aa* on 10–18 segments decreasing significantly; on 19–23 *aa* increasing, becoming similar to *aa* on 10, running at edge of ventral border

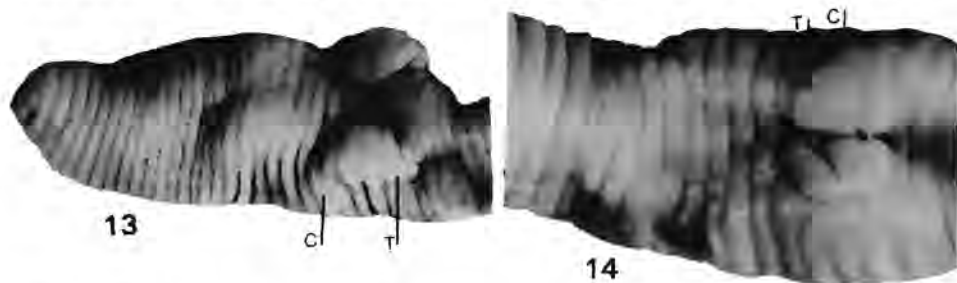
of tubercula pubertatis. Only pairs of *ab* were observed; *cd* not observed. On paratypes similar arrangement was observed. *Nephridial pores*: Not observed. *Female pores*: Minute openings in posterior part of segment 14, close to 14/15 intersegmental furrow, in line of ventral edges of clitellum. *Male pores*: Probably in intersegmental furrow 19/20, on tubercula pubertatis, where there are small depressions. *Spermathecal pores*: Conspicuous in intersegmental furrows 11/12, 12/13.

Clitellar region (Fig. 13): *Clitellum*: Saddle-shaped, segmented, whitish-grey; holotype 13–23. *Tubercula pubertatis*: Irregularly oval, glandular swellings; separated from clitellum by narrow grooves; widely distributed ventrally. *Papillae*: Paired, small on 10–12, enlarged on 13–15, moderate on 16–19; all associated with *ab* setae and genital glands.

Internal characters:

Septa: 4/5 thickened moderately, 5/6, 6/7 very thick, similar in thickness and appearance; 7/8, 8/9 less thickened; 9/10 aborted; other septa moderate. *Gizzard*: Large, muscular, in 6–7; commencing in 6, extends and occupies whole of 7, terminating abruptly at septum 7/8. *Calciferous glands*: Not stalked; hemispherical, firm; in 9–10, dorsolaterally; ventrally separated widely, dorsally by short distance. *Intestine*: Commences in 13. *Typhlosole*: In holotype commences as V-shaped in 19, somewhat enlarging in the following segments, terminates in area of 50. *Dorsal blood vessel*: Double in 4–11; double also when crossing septa 4/5–10/11; in 12 and the following segments single. *Paired dorsoventral commissural vessels*: In 4–8 thin, gradually enlarging tubes; in 9–11 thick, moniliform 'hearts'. *Nephridia*: In posterior segments two small pairs: ventral close to median body line, lateral dorsolaterally; in preclitellar segments nephridia larger than those from posterior segments.

Reproductive organs: *Spermiductal funnels*: Holandric arrangement (in 10 and 11); two pairs of very small, empty funnels, similar in size and appearance, enclosed in sacs, connected with vesiculae seminales. *Seminal vesicles*: Two pairs of small sacs, linked with testis sacs; in 10 and 11. *Spermathecae*: Small ampullae, close to septa 11/12, 12/13; one, two or multiple at each side, deeply embedded in tissue. *Ovaries*: In 13. *Genital glands*: In segments 10–19, flat, round glands, with no genital setae.



Figs 13–14. *Tritogenia* species. 13. *T. miniseta* sp. n., anterior part of body, ventral view. 14. *T. ngelensis* sp. n., clitellar region, ventral view. [C = clitellum; T = tuberculum pubertatis.]

Biological notes: Found in marshy grassland soil, near indigenous shrubs and trees. Occurs in the top layer, down to 20 cm, between grass-roots.

Distribution: Known only from the type locality in Itala Game Reserve, in northern KwaZulu-Natal.

Discussion: This is one of the large group of species characterised by the position of spermathecal pores in 11/12, 12/13 intersegmental furrows. In its distinctive arrangement of minute setae, and the shape of the calciferous glands, it is similar to *diversa* sp. n., although they differ in the shape of the tubercula pubertatis and the number and shape of papillae.

***Tritogenia ngelensis* sp. n.**

Fig. 14

Etymology: Named after the type locality, Ngele Forest, in KwaZulu-Natal.

Material examined: *KwaZulu-Natal:* Holotype: clitellate NMSA/Olig.02203, Ngele Forest (30°35'S:29°41'E), indigenous, mixed forest, from top 20 cm of moist soil, under thick litter, 24 November 1995. Paratypes: collected with holotype, 10 clitellate and 2 juvenile NMSA/Olig.02187. Other material: from the same locality: 10 clitellate and 10 juvenile from litter and top layer of sandy soil, 23 November 1995, NMSA/Olig.02182; 5 clitellate from a heap of decomposed litter, 24 November 1995, NMSA/Olig.02195. All material collected by JDP & BRS.

Description based on holotype and paratypes.

External characters:

General: Body cylindrical, soft in life, hardened after formalin preservation. **Colour:** Whitish-grey in life; preserved dark grey. **Dimensions:** Preserved and contracted: holotype 55 mm long, 5 mm wide at 10, 6 mm in region of tubercula pubertatis; clitellate paratypes: 45–62 mm long, 6 mm wide at tubercula pubertatis; juvenile: 28–30 mm long, 2 mm wide. **Segment number:** Holotype 89; paratypes: clitellate 76–94; juveniles 75–92. **Prostomium:** Epilobous, open, small. **Segmentation:** Secondary annulation present in holotype and paratypes: 1–3 simple, 1–2 with irregular longitudinal grooves; 4–9 with 2 simple ringlets, similar in size and appearance; 10 and the following simple; clitellar segments, dorsally simple, ventrally irregularly annulated; postclitellar simple, randomly and irregularly annulated. **Setae:** Minute, closely paired; first pairs of *ab* on 7; the distance between *aa* on 10–14 diverging, on 15–18 converging; on clitellar segments setae not observed; postclitellarly in longitudinal, uneven rows; pairs of *cd* not observed. **Nephridial pores:** Not observed. **Female pores:** On 14, minute openings. **Male pores:** Not detected externally; probably in 18/19 intersegmental furrow. **Spermathecal pores:** Conspicuous externally in intersegmental furrows 11/12, 12/13.

Clitellar region (Fig. 14) : **Clitellum:** Saddle-shaped, segmented, whitish-grey; holotype on 13–22; paratypes: dorsally on 13–22, 23, extending to dorsal border of tubercula pubertatis. **Tubercula pubertatis:** On 1/n18,19–21,1/n22; commences below well-defined clitellar edges; separated from clitellum by narrow rims on 19–21; ventrally extends close to median line; ventrally separated distinctly by segmented narrow strip; glandular, nearly square with rounded corners, with clear intersegmental furrows and irregular shallow grooves. **Papillae:** Paired, small swellings in *ab* setal lines, on all or some of segments 10–18 and 22, 23.

Internal characters:

Septa: 4/5 thin; 5/6 and 6/7 thickened very much, muscular; 7/8, 8/9 thickened moderately, both similar in size and appearance; segment 8 very short; septum 9/10 thin, partly aborted; other septa in preclitellar segments very thin, in posterior segments slightly stronger. *Crop*: Large, in 4 and 5. *Gizzard*: Large; commencing in 6, extends into and occupies whole of 7, terminating at septum 7/8. *Calciferous glands*: Not stalked; in 9 and 10; composed of two parts; in segment 9 globular soft, dorsally with tiny groove, lamellar; in 10 firm, horseshoe-shaped, closely connected with oesophagus, ventrally more widely separated, dorsally with narrow groove. *Intestine*: Commences in 13. *Typhlosole*: Commences as V-shaped in 21, enlarging abruptly into thick tube; terminates in holotype in 51, in dissected paratype in 56. *Dorsal blood vessel*: Double in 4–11; double also when crossing septa 4/5–11/12; in 12 and the following segments usually single, however, in some postclitellar segments vessel has double structure. Ventral vessel very thin, single. *Paired dorsoventral commissural vessels*: In 4–8 slender tubes; in 9–11 thick, moniliform ‘hearts’ connected with ventral vessel posteriorly. *Nephridia*: In posterior segments two small pairs; dorsal pairs with long, thin tubes; ventral pairs close to median body line, with shorter tubes; in preclitellar segments nephridia much larger than those from posterior segments.

Reproductive organs: *Spermiductal funnels*: Holandric arrangement (in 10 and 11); two pairs of funnels, similar in appearance; first pair smaller than the second; both enclosed in separated sacs, connected closely with vesiculae seminales; in all dissected specimens sperm was observed in both funnels. *Seminal vesicles*: Two pairs of moderately sized sacs, linked with testis sacs; in 10 and 11. *Spermathecae*: Minute, slender, bent or serpentine, tube-like, close to septa 11/12, 12/13; 2–5 at each side. *Ovaries*: In 13; large, funnel-like, with long oviducts, near septa 13/14. *Genital glands*: Flat glands, associated with papillae and *ab* setae; in segments 13, 14 very small; in 22 and 23 moderate in size, composite of 3–4 oval or half-oval glands.

Biological notes: Found in moderately moist, sandy soil, in indigenous forest. The natural vegetation is mixed *Podocarpus* with thick bush and shrubs characteristic of Afromontane forests. Although the indigenous part is surrounded by plantations of pine, cypress and poplar trees, no exploitation - except for the removal of dead trees - has taken place where this species was collected. The sample, collected in early summer, contains both mature and juvenile specimens. In mature specimens sperm was observed in spermiductal funnels, confirming breeding activity at this time. Casts were observed below the surface, sometimes as deep as 20 cm. When alive, these earthworms are clumsy and move slowly; when disturbed, they immediately contract the whole body up to half its relaxed length. Specimens discharge much mucus during preservation.

Associated with indigenous *Microchaetus* spp., species of Acanthodrilidae, and also introduced species of Lumbricidae: *Dendrobaena rubida* (Sav.), *Octolasion lacteum* (Oerley).

Distribution: Known only from the Ngele Forest, an indigenous forest included in the Weza State Forest, situated in southern KwaZulu-Natal.

Discussion: A distinctive species. The oesophageal portion of the lamellar calciferous glands located in segment 9 is very distinctive, not observed in other species of the genus.

***Tritogenia palusicola* sp. n.**

Fig. 15

Etymology: *L. palus* = marsh, swamp; refers to the biotope.

Material examined: *Mpumalanga*: Holotype: clitellate NMSA/Olig.02328, 32 km W. Volksrust (27°32'S:29°53'E), on bank of Skulpspruit River, under willow tree (*Salix* sp.), marshy, wet soil, 3 December 1992, JDP & BRS. Paratypes: collected with holotype, 5 not fully mature specimens, NMSA/Olig.01834.

Description based on holotype and paratypes.

External characters:

General: Body in life soft. Preserved also soft. *Colour*: In life and preserved whitish-grey. *Dimensions*: Holotype preserved and contracted 38 mm long, 6 mm wide at tubercula pubertatis. *Segment number*: Holotype 100. *Prostomium*: Prolobous. *Segmentation*: 1–3 simple, 1–2 with longitudinal grooves; 4–8 with two simple ringlets, similar in size and appearance; 9–10 with two ringlets, second ringlet shorter than first; 11 and the following simple, randomly annulated. *Setae*: Very small, plain; paired; $aa > bc$; first pairs of ab and cd on first ringlet of 7; preclitellarly and in area of tubercula pubertatis $ab > cd$; on 11–13 and 18–24 associated with papillae. *Female pores*: On 14 above ab setal lines. *Male pores*: Probably in 19/20, where there are small invaginations. *Spermathecal pores*: In intersegmental furrows 11/12 12/13.

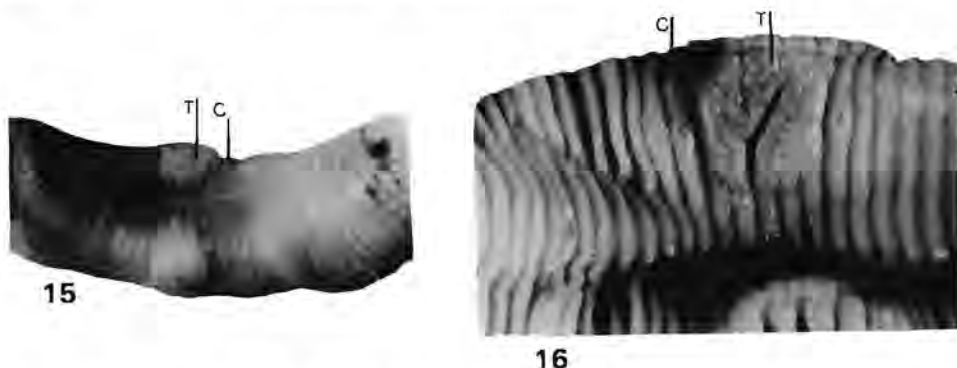
Clitellar region (Fig. 15): *Clitellum*: Saddle-shaped, in paratypes not fully developed; holotype 13–24. *Tubercula pubertatis*: Irregularly rounded glandular cushions; on 1/n18–21; separated from clitellum by narrow grooves; ventrally extending to papillae. *Papillae*: Paired swellings; on 11–13 and 18–24, glandular, with no genital papillae.

Internal characters:

Septa: 5/6–8/9 thickened moderately, similar in size and appearance; other septa postclitellarly thin. *Gizzard*: In 6–7, with the only small part in 6; muscular. *Calciferous glands*: In 9–10, dorsolateral; horseshoe-shaped, not stalked; widely separated ventrally, with narrow groove dorsally. *Intestine*: Commences in 13. *Typhlosole*: Commences in 20. *Dorsal blood vessel*: Doubled in 4–11 and when crossing septa; in 4–7 moderate in size, in 8–11 much enlarged; 12 and posterior single, moderate. *Paired dorsoventral commissural vessels*: 4–8 thin tubes, 9–11 enlarged, moniliform 'hearts'. *Nephridia*: Two small pairs per segment.

Reproductive organs: *Spermiductal funnels*: Holandric arrangement (in 10 and 11); small, empty funnels, enclosed in testis sacs. *Spermathecae*: Very small ampullae, laterally, near septa 11/12 and 12/13; 1 pair per segment. *Seminal vesicles*: Very small, empty sacs, in 10 and 11. *Genital glands*: Small, paired, in 18–24, with unornamented, minute setae; with no genital setae.

Biological notes: Collected in early summer, from marshy, soaked soil; found



Figs 15–16. *Tritogenia* species. 15. *T. palusicola* sp. n., clitellic region, ventral view. 16. *Tritogenia soleata* sp. n., part of ventral clitellic region. [C = clitellum; T = tuberculum pubertatis.]

between grass-roots. Despite the well-developed clitellum and tubercula pubertatis in the majority of specimens, and also good biological conditions where they were found, the spermiductal funnels and spermathecae in all dissected specimens were empty. Associated with introduced *Allolobophora trapezoides* (Dugès, 1828), *Allolobophora rosea* (Savigny, 1826) and species of the *Pheretima* group.

Distribution: Known only from the type locality. It is uncertain if this species is endemic at this locality or introduced from elsewhere, as it occurred with introduced species.

Discussion: Belongs to a large group of species with spermathecal pores in 11/12 and 12/13. Similar to *douglasi* sp. n., sharing the characters of the position of the spermathecal pores and clitellum; they differ, however, in the shape of the tubercula pubertatis and calciferous glands.

***Tritogenia soleata* sp. n.**

Fig. 16

Etymology: L. *solea* = horseshoe. Refers to the shape of the calciferous glands.

Material examined: *KwaZulu-Natal*: Holotype: clitellate, Pietermaritzburg, coll. Pueketi [Quekett] BMNH:1893:12:16:3.

Description based on holotype.

External characters:

General: Body cylindrical, hardened and contracted in preservation. *Colour*: Preserved yellowish-grey. *Dimensions*: Contracted: 80 mm long, 15 mm wide at 10, 17 mm in region of tubercula pubertatis. *Segment number*: 110. *Prostomium*: Probolous, large. *Segmentation*: Secondary annulation present: 1–3 simple, 1–2 with irregular longitudinal grooves; 4–9 with 2 simple ringlets, similar in size and appearance; 10 and the following segments simple, preclitellarly very short; ventrally irregularly annulated; postclitellar simple, randomly annulated. *Setae*: Minute, closely paired; first pairs of *ab* noticeable on 4; *cd* not observed. *Nephridial pores*: Not observed. *Female pores*: On 14, large openings on posterior portion of segment, above *ab* setal lines. *Male pores*: In 18/19 intersegmental furrow. *Spermathecal*

pores: In intersegmental furrows 10/11, 11/12.

Clitellar region (Fig. 16): *Clitellum*: Saddle-shaped, segmented, yellowish-grey; on 14–24; ventral borders terminate parallel to dorsal edges of tubercula pubertatis. *Tubercula pubertatis*: On 18–22, below clitellar edges, extending to *ab* setal lines; separated from clitellum by narrow rim; ventrally separated by segmented field; glandular, nearly square, segmented. *Papillae*: Paired small swellings in *ab* setal lines, on 16, 23.

Internal characters:

Septa: 4/5 thickened little; 5/6–8/9 very much thickened, similar in appearance; 9/10 very thin, partly aborted; other septa in preclitellar segments thin; in posterior segments slightly thicker. *Gizzard*: Large, muscular; commencing in 6, extends and occupies whole of 7, terminating abruptly at septum 7/8. *Calciferous glands*: Not stalked, in 9–10; closely connected with oesophagus; horseshoe-shaped, ventrally widely separated, dorsally with slim groove. *Intestine*: Commences abruptly in 13. *Typhlosole*: Commences gradually as V-shaped in area of 23. *Dorsal blood vessels*: double in 4–11 and also when crossing septa 4/5–10/11; in 12 and the following segments single. *Paired dorsoventral commissural vessels*: In 4–8 slender tubes; in 9–11 thick, moniliform ‘hearts’. *Nephridia*: In posterior segments two small pairs.

Reproductive organs: *Spermiductal funnels*: Holandric arrangement (in 10 and 11); two pairs of funnels, similar in appearance; enclosed in separated sacs, connected very closely with vesiculae seminales. *Seminal vesicles*: Two pairs moderately-sized sacs, linked with testis sacs; in 10 and 11. *Spermathecae*: Small ampullae of various shapes, close to septa 10/11, 11/12; in first segment one spermatheca at right side, two at left; in second segment four at right, three at left side. *Ovaries*: In 13; large, funnel-like near septa 13/14. *Genital glands*: Flat glands, associated with papillae and *ab* setae, in 16 and 23; each gland composed of 3–4 half-oval structures.

Biological notes: No data are provided on the label.

Distribution: Known only from Pietermaritzburg, KwaZulu-Natal.

Discussion: Most similar to *shawii* Plisko & Zicsi, 1991; the position of the spermathecal pores in 10/11 and 11/12, and the tubercula pubertatis on 18–22, are shared characters. They differ in the position of the clitellum and the shape of the calciferous glands.

The holotype is deposited in the Oligochaeta collection, The Natural History Museum, London.

mucosa species-group

Key to species of *mucosa* species-group

- 1 Spermathecal pores in intersegmental furrows 10/11, 11/12, 12/132
- Not so5
- 2 Tubercula pubertatis invaginated; calciferous glands stalked3
- Tubercula pubertatis glandular, oval, not invaginated; calciferous glands not stalked4

- 3 Clitellum commences on 12, terminates on 24 **alveata** sp. n.
- Clitellum commences on 13, terminates on 23; calciferous glands stalked
koilia sp. n.
- 4 Clitellum terminates on 22; tubercula pubertatis oval, on 18,19–21,22;
 calciferous glands widely separated ventrally, dorsally with tiny groove
mucosa Plisko & Zicsi, 1991
- Clitellum terminates on 23; tubercula pubertatis elongated oval, segmented, on
 1/n18–1/n22 **silvicola** sp. n.
- Clitellum terminates on 25,26; tubercula pubertatis oval, segmented, on 18–22
turneri sp. n.
- 5 Spermathecal pores in 11/12, 12/13, 13/14; clitellum on 13–21,22; tubercula
 pubertatis on 19–20 with mutual median invagination; calciferous glands
 stalked **liversagei** sp. n.
- Spermathecal pores in 13/14, 14/15, 15/16; clitellum on 14,15–25,26; tubercula
 pubertatis on 1/n17,18–22, trapeziform; calciferous glands stalked
insolita sp. n.

Tritogenia alveata sp. n.

Fig. 17

Etymology: *L. alveus* = depression, alveolus. Refers to the unusual shape of the tubercula pubertatis.

Material examined: *KwaZulu-Natal*: Holotype: clitellate NMSA/Olig.02094, Qudeni Forest (28°39'S:30°53'E), mistbelt mixed *Podocarpus* forest, from top 15 cm of moist soil, under thick litter, 23 January 1995, JDP & BRS. Paratypes: collected with holotype, 5 clitellate, 4 juvenile NMSA/Olig.02173.

Description based on holotype and paratypes.

External characters:

General: Body cylindrical, soft in life, hardened after formalin preservation. *Colour*: Pinkish-grey in life; preserved dark grey except last 5–7 segments which are brown. *Dimensions*: Preserved and contracted: holotype 58 mm long, 4.5 mm wide at 10 and in region of tubercula pubertatis; clitellate paratypes: 25–58 mm long, 3–5 mm wide at tubercula pubertatis; juvenile 28–30 mm long, 2 mm wide. *Segment number*: Holotype 90; paratypes: clitellate 57–89; juveniles 81–84. *Prostomium*: Prolobous, small. *Segmentation*: Secondary annulation present in holotype and paratypes: 1–3 simple, 1–2 with irregular longitudinal grooves; 4–9 with 2 simple ringlets, similar in size and appearance; 10–11 superficially annulated into 2 annuli; clitellar segments dorsally simple, ventrally irregularly annulated; postclitellar simple, randomly irregularly annulated. *Setae*: Minute, closely paired; first pairs of *ab* visible under high magnification on 7; the following pairs *ab* more easily seen, *cd* not seen. *Nephridial pores*: Not observed. *Female pores*: On 14, minute openings with small swellings, in posterior part of segment 14 in front of *ab* setae. *Male pores*: Not detected externally; probably in 18/19 intersegmental furrow, where there are small depressions. *Spermathecal pores*: Conspicuous in intersegmental furrows 10/11, 11/12, 12/13.

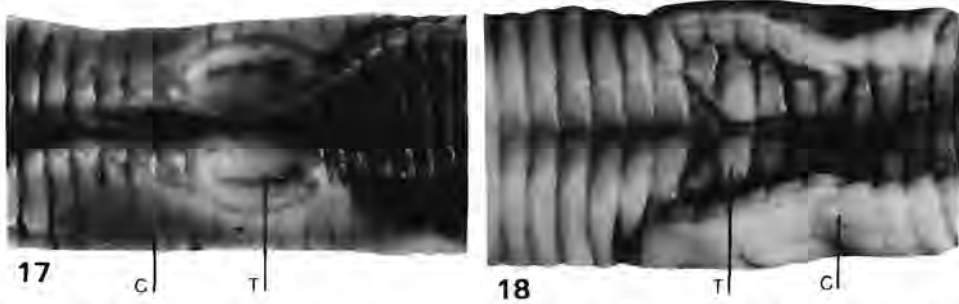
Clitellar region (Fig. 17): *Clitellum*: Saddle-shaped, segmented, whitish-grey; holotype on 1/n12–1/n24; paratypes dorsally on 1/n12,12–1/n24,24. On segments 13–17 extended to *ab* setal lines; the following segments covered by clitellar tissue to the dorsal border of tubercula pubertatis. *Tubercula pubertatis*: On 18–22, below well-defined clitellar edges; on 19–21 hollowed glandular swellings, pocket-like invaginated formations divided by intersegmental furrows and irregular shallow grooves; narrow rims extend around invaginated parts, expanding on 18 and 22, enclosing entire depressions; medially separated by segmented field. *Papillae*: Paired, or single, small swellings in *ab* setal lines, on all or some of segments 11–17 and 23.

Internal characters:

Septa: 4/5, 5/6, 6/7 thickened very much, similar in thickness and appearance; 7/8, 8/9 thickened moderately, strong; 9/10 very thin, partly aborted; other septa in preclitellar segments very thin; in posterior segments slightly stronger. *Gizzard*: Large, muscular, in 6–7; commencing in posterior part of 6, extends and occupies whole of 7, terminating abruptly at septum 7/8. *Calciferous glands*: One pair, stalked, dorsolateral, muscular; in 9–10; each gland connected with oesophagus by globular, soft stalk in 9; muscular glands occur partly in 9, projecting into 10, where thin vessels, expanded from enlarged dorsoventral blood vessels, enter dorsally into muscular gland. *Intestine*: Commences in 13. *Typhlosole*: Commences as V-shaped in 15, and gradually enlarges into thick, nearly square tube; terminates in holotype in 45, in dissected paratype in 47. *Dorsal blood vessel*: Double in 4–11; double also when crossing septa 4/5–9/11; in 12 and following segments single. Ventral vessel very thin in 4–10, enlarged in 11 and following segments. *Paired dorsoventral commissural vessels*: In 4–8 thin, gradually enlarging tubes; in 9–11 thick, moniliform ‘hearts’ connected with ventral vessel backwards. *Nephridia*: In posterior segments two small pairs; dorsal pairs with long, thin tubes; ventral pairs with shorter tubes, close to median body line; in preclitellar segments nephridia much larger than those from posterior segments.

Reproductive organs: *Spermiductal funnels*: Holandric arrangement (in 10 and 11); two pairs of funnels, of similar size and appearance, enclosed in separated sacs, connected with vesiculae seminales; in all dissected specimens sperm was observed. *Seminal vesicles*: Two pairs of moderately-sized sacs, linked with testis sacs; in 10 and 11. *Spermathecae*: Minute, bent or serpentine tube-like, with no diverticula; close to septa 10/11, 11/12, 12/13; in holotype one pair per segment. *Ovaries*: In 13; large, funnel-like with long oviducts, extend to area of septa 13/14. *Genital glands*: Five pairs of flat glands, associated with papillae and *ab* setae, in segments 12, 13, 14, 15, 16; each gland composed of 3–4, moderately sized, oval or half-oval structures.

Biological notes: Found in damp, sandy soil in forest, near degraded roadside. The sample, collected in summer, consists of both mature and juvenile specimens. Sperm was observed in spermiductal funnels in dissected mature specimens, confirming breeding activity in summer. No casts were observed on the surface at collection sites. When alive, these earthworms are clumsy, with slow movements, but when disturbed, they contract the whole body to half its relaxed length.



Figs 17–18. *Tritogenia* species, clitellar region, ventral view. 17. *T. alveata* sp. n. 18. *T. insolita* sp. n. [C = clitellum; T = tuberculum pubertatis.]

Distribution: Known only from the Qudeni Forest in KwaZulu-Natal. The natural vegetation there is *Podocarpus* with many other species of trees characteristic of Afromontane forests.

Discussion: A distinctive species, resembling *koilia* sp. n. The location of spermathecal pores and the unusual condition of the invaginated tubercula pubertatis, are shared characters. They differ in general appearance, the position of the clitellum, the location and shape of the typhlosole, and the number and shape of genital glands. Representatives of *alveata* sp. n. are much smaller than those of *koilia* sp. n. The highly specific shape of the tubercula pubertatis, similar only to that in *koilia*, is not recorded in other *Tritogenia* species.

***Tritogenia insolita* sp. n.**

Fig. 18

Etymology: *L. insolitus* = unusual; refers to the unique position of the spermathecae.

Material examined: *KwaZulu-Natal:* Holotype: clitellate NMSA/Olig.02029, Kranskop indigenous forest (28°59'S:30°53'E), from litter and top layer of moist soil, 8 December 1994, JDP & BRS. Paratypes: collected with holotype, 6 mature and 3 juvenile, NMSA/Olig.02320.

Description based on holotype and paratypes.

External characters:

General: Body in life firm. Preserved much shortened, with contracted segments. **Colour:** In life whitish-grey. Preserved yellowish-grey. **Dimensions:** Preserved, contracted: Holotype 84 mm long, 8 mm wide at 10, 10 mm at tubercula pubertatis; paratypes 48–78 mm long. **Segment number:** Holotype 80; paratypes 65–86. **Prostomium:** Prolobous. **Segmentation:** 1–3 simple, 1–2 with longitudinal grooves; 4–8 with two simple ringlets, similar in size and appearance; 9–10 with two ringlets, second ringlet shorter than first; 11 and the following segments simple, randomly annulated. **Setae:** Closely paired, easily seen; first pairs of *ab* on first ringlet of 6; *ab* = *cd*; postclitellarly *aa* : *bc* = 5 : 3; distance between *ab* setal lines increases slightly on 16; on 17 and 18 approaching one another; on 19–22 *ab* on ventral edges of tubercula pubertatis; posteriorly both lines of *ab* and *cd* reveal slight irregularity.

Female pores: On 14 above *ab* setal lines. *Male pores*: Probably on 19, where there are small invaginations near ventral lines of tubercula pubertatis. *Spermathecal pores*: In intersegmental furrows 13/14, 14/15, 15/16.

Clitellar region (Fig. 18): *Clitellum*: Saddle-shaped; holotype 15–25; paratypes 14, 15–25, 26. *Tubercula pubertatis*: On 1/n17, 18–22; commence at ventral edges of clitellum, terminate near median body line; dorsally rimmed, ventrally separated by narrow field; almost trapeziform, rounded posteriorly; glandular, segmented cushions. *Papillae*: Paired, small swellings on 17, 23, 24.

Internal characters:

Septa: 4/5 thickened moderately; 5/6–6/7 much thickened, 7/8–8/9 thickened less than 7/8; 8/9 thin; other septa moderate. *Gizzard*: In 6–7; septum 6/7 adherent in 1/5 of gizzard length. *Calciferous glands*: Stalked; in 9–10, dorsolaterally. *Intestine*: Commences in 13. *Typhlosole*: In paratype with 76 segments, commences in area of 20, terminates in 45. *Dorsal blood vessel*: Doubled in 4–11; in 4–7 thin tubes, in 8 somewhat enlarged, in 9–11 enlarged. *Paired dorsoventral commissural vessels*: 4–8 thin tubes, 9–11 enlarged, moniliform ‘hearts’. *Nephridia*: Two pairs per segment.

Reproductive organs: *Spermiductal funnels*: Holandric arrangement (in 10 and 11); enclosed in testis sacs; in one paratype second pair of funnels was free. *Spermathecae*: Tiny ampullae near septa 13/14 14/15 15/16; 2–7 per side. *Seminal vesicles*: Small sacs in 10 and 11, projecting into 12; closely attached to sacs of spermiductal funnels. *Ovaries*: Large, funnel-like, in posterior part of 13. *Genital glands*: In 17, 23, 24 or 16, 17, 23, 24; flat glands three- or four-branched, partly separated by narrow grooves.

Biological notes: Collected in indigenous mistbelt forest. Associated with *T. koilia* sp. n. and acanthodrilids.

Distribution: Known only from the type locality in KwaZulu-Natal.

Discussion: A distinctive species with the unique position of spermathecae in intersegmental furrows 13/14, 14/15, 15/16.

***Tritogenia koilia* sp. n.**

Figs 19–20

Etymology: Gr. *koilia* = cavity. Refers to the shape of the tubercula pubertatis.

Material examined: *KwaZulu-Natal*: Holotype: clitellate NMSA/Olig.02030, Kranskop Forest (28°59'S:30°53'E), mistbelt mixed *Podocarpus* forest, from litter and top layer of the soil, 8 December 1994, JDP & BRS. Paratypes: collected with holotype, 7 clitellate and 5 juvenile NMSA/Olig.02174.

Description based on holotype and paratypes.

External characters:

General: Body cylindrical, plump; hardened by formalin preservation. *Colour*: Whitish-grey in life; preserved yellowish-grey; *Dimensions*: Preserved and contracted: holotype 56 mm long, 6 mm wide at 10 and in region of tubercula pubertatis; clitellate paratypes: 45–69 mm long, 5–8 mm wide at tubercula pubertatis;

juvenile 17–32 mm long, 3 mm wide. *Segment number*: Holotype 75; paratypes: clitellate 70–78; juveniles 70–81. *Prostomium*: Prolobous, large. *Segmentation*: Secondary annulation in holotype and paratypes: 1–3 simple, 1–2 with irregular longitudinal grooves; 4–9 with 2 simple ringlets, similar in size and appearance; 10, 11 and postclitellar simple, randomly and irregularly annulated; clitellar segments, dorsally simple, ventrally irregularly annulated. *Setae*: Minute, closely paired; first pairs of *ab* on 4; postclitellar larger than preclitellar; *cd* very deeply embedded in body tissue, difficult to see externally. *Nephridial pores*: Not observed. *Female pores*: On 14, minute openings in *ab* setal lines. *Male pores*: Probably in 18/19 intersegmental furrow, where there are small depressions. *Spermathecal pores*: Evident externally in intersegmental furrows 10/11, 11/12, 12/13.

Clitellar region (Figs 19–20): *Clitellum*: Saddle-shaped, segmented, whitish-grey; on holotype and paratypes on 13–23, with clear anterior and posterior borders; on 13–17 and 23 extends to *ab* setal lines, on 18–22 to dorsal border of tubercula pubertatis. *Tubercula pubertatis*: On 18–22, below well-defined clitellar edges; in life manifesting as glandular swellings; on preserved specimens glandular parts comprise pocket-like invaginated structures on 19–21; narrow rims surrounding invaginated parts of tubercula extend on 18 and 22; the proportion of invaginated section of tubercula differs somewhat on paratypes examined, apparently depending on state of maturity. Occasionally grooved by intersegmental furrows and irregular shallow notches. Ventrally separated by narrow segmented field. *Papillae*: Paired, or single; small swellings in *ab* setal lines, on 10–12 simple, on 13 and 17 with little nipples.



Figs 19–20. *Tritogenia koilia* sp. n., clitellar region, ventral view. 19. Holotype. 20. Paratype. [C = clitellum; T = tuberculum pubertatis.]

Internal characters:

Septa: 4/5, 5/6, 6/7 thickened very much, similar in thickness and appearance; 7/8, 8/9 thickened moderately, strong; other septa in preclitellar segments very thin; in posterior segments slightly stronger. *Gizzard*: Large, muscular, in 6–7; commencing in anterior part of 6, extends to 7 occupying whole segment; terminates abruptly at septum 7/8. *Calciferous glands*: One pair stalked, dorsolateral; in 9–10; connected with oesophagus by tubular soft stalk in 9; muscular glands occur partly in 9, projecting into 10, where thin vessels, expanded from enlarged dorsoventral blood vessels, enter into external, muscular tissue of both glands. *Intestine*: Commences in 13. *Typhlosole*: Commences as V-shaped in 20; in the following 3–7 segments gradually enlarging, and changing into double-furrowed structure; terminates in area

of 46. *Dorsal blood vessel*: Double in 4–11 and when crossing septa 4/5–9/11; in 12 and the following segments single. *Ventral vessel* thin in 4–10, enlarged in 11 and following segments. *Paired dorsoventral commissural vessels*: In 4–8 thin, gradually enlarging tubes; in 9–11 thick, moniliform ‘hearts’ connected posteriorly with ventral vessel. *Nephridia*: In postclitellar segments two small pairs; dorsal pairs with long, thin tubes; ventral pairs with shorter tubes, close to median body line; in preclitellar segments nephridia much larger than those from posterior segments.

Reproductive organs: *Spermiductal funnels*: Holandric arrangement (in 10 and 11); two pairs of funnels, of similar size and appearance, enclosed in separated sacs, connected with vesiculae seminales; in all dissected specimens sperm was observed. *Seminal vesicles*: In 10 and 11; two pairs of moderately sized sacs, linked with testis sacs. *Spermathecae*: One pair per segment; very long, tube-like, bent or serpentine; in all dissected specimens spermathecae were observed only in two segments, close to septa 11/12, 12/13; first pairs of 10/11 were probably embedded in body tissue; external openings in intersegmental furrow 10/11 indicate presence of spermathecae in this area. *Ovaries*: In 13; large, funnel-like, with long oviducts running to septa 13/14. *Genital glands*: Two pairs associated with papillae in *ab* setae lines; in segment 13 one pair of medium size, composed of four finger-shaped glands; in 18 flat, circular, composed of 3–4 half-oval glands.

Biological notes: Found near a small stream in moist forest soil, under a thick layer of litter. The early summer sample of 13 specimens includes clitellate and juvenile individuals. In all dissected mature specimens sperm was found in spermiductal funnels, confirming breeding activity at that season.

No casts were observed on the surface at collection sites. When alive, these earthworms are plump, clumsy with slow movement, but when disturbed they instantly contract the whole body to half its relaxed length. Preserved specimens also reveal this degree of contraction.

Associated with *insolita* sp. n. and *acanthodrilids*.

Distribution: Known only from Kranskop Forest in KwaZulu-Natal, a fairly typical Afromontane mistbelt forest. The forest is in a narrow valley below high cliffs on the south side of the Tugela River. In the distance on the opposite side of the valley, the Qudeni Forest can be seen where the related species *alveata* lives.

Discussion: A distinctive species, most similar to *alveata* sp. n. The characteristic shapes of the tubercula pubertatis and the calciferous glands are similar in both species. They differ in general appearance, *koilia* being much larger than *alveata*; also in the position of the clitellum, typhlosole, and the number and shape of the genital glands. The shape of the tubercula pubertatis, similar only to that of *alveata*, is not recorded in other *Tritogenia* species.

***Tritogenia liversagei* sp. n.**

Fig. 21

Etymology: Named for Mr T. Liversage, who has assisted me on a number of my collecting expeditions.

Material examined: *KwaZulu-Natal*: Holotype: clitellate NMSA/Olig.01820, Itala

Game Reserve, near Nkwekhwana River (27°35'S:31°13'E), at ca. 800 m, bank of natural pool in grassland, 1 December 1993, JDP, TL & D McC. Paratypes: collected with holotype, 4 clitellate complete, 1 abscised, 10 juvenile, NMSA/Olig.02325; Itala Game Reserve, near second entrance to Reserve (27°32'S:31°23'E), grassland, 3 clitellate, 1 juvenile, 1 December 1993, JDP, TL & DMcC, NMSA/Olig.01828; 28 km E. Vryheid, Farm Nyaliza (27°32'S:31°27'E), pasture, 2 clitellate, 2 semi-mature, 27 November 1993, JDP, TL & DMcC, NMSA/Olig.01770. Other material: *KwaZulu Natal*, Itala Game Reserve, along Mhlangeni road (27°33'S:31°15'E), at ca. 680 m, grassland, from hard soil, 8 semi-mature, 30 November 1993, JDP, TL & DMcC, NMSA/Olig.01805. *Mpumalanga*: 10 km N. Lydenburg (25°06'S:30°27'E), *Acacia* bush, from dry soil, 1 semi-mature, 1 juvenile (both in anabiotic state), 6 December 1995, JDP & TL, NMSA/Olig.02229.

Description based on holotype and paratypes.

External characters:

General: Body cylindrical, plump. *Colour*: Grey in life; preserved greyish-white; *Dimensions*: Preserved and contracted: holotype 50 mm long, 6 mm wide at 10, 7 mm in region of tubercula pubertatis; clitellate paratypes: 33–54 mm long, 5–8 mm wide at tubercula pubertatis; juvenile 13–37 mm long, 3 mm wide. *Segment number*: Holotype 87; paratypes: 80–91. *Prostomium*: Prolobous, small. *Segmentation*: Secondary annulation present in holotype and paratypes: 1–3 simple, 1–2 with irregular longitudinal grooves; 4–9 with 2 simple ringlets, similar in size and appearance; clitellar segments, dorsally simple, ventrally irregularly annulated; postclitellar simple, randomly and irregularly annulated. *Setae*: Minute, closely paired; first pairs of *ab* on 9; *aa* > *bc*. *Nephridial pores*: Not observed. *Female pores*: On 14, minute openings. *Male pores*: Probably in 19/20 intersegmental furrow, where depressions occur on tubercula pubertatis. *Spermathecal pores*: Not noticeable externally; in dissected specimens close to intersegmental furrows 11/12, 12/13, 13/14.

Clitellar region (Fig. 21): *Clitellum*: Saddle-shaped, segmented, yellowish-white; on 13–21, 22; lateral borders above tubercula pubertatis. *Tubercula pubertatis*: On 18–21, below well-defined clitellar edges; in life manifesting as glandular swellings; on preserved specimens the glandular parts of 19–20 form median, single invaginated structures; enlarged rims on 18 and 21 enclose invaginated part of both tubercula; the proportion invaginated varies, probably depending on state of maturity. *Papillae*: Paired, or single; small swellings, paired or single, in *ab* and *cd* setal lines, on all or on some of 12–16, 22, 23.

Internal characters:

Septa: 5/6, 6/7, 7/8, 8/9 thickened moderately, strong; 7/8 and 8/9 less than 5/6 or 6/7; other septa in preclitellar segments very thin; in posterior segments slightly stronger. *Gizzard*: Large, muscular, in 6–7; commencing in 6, extends to 7. *Calciferous glands*: One pair stalked, dorsolateral, muscular, in 9–10; connected with oesophagus by tubular soft stalk in 9; muscular glands occur partly in 9, projecting into 10. *Intestine*: Commences in 13. *Typhlosole*: Commences as V-shaped in 19, gradually enlarging, terminates in area of 51. *Dorsal blood vessel*: Double in 4–11, and when crossing septa 4/5–9/11; in 12 and the following segments single. *Paired*

dorsoventral commissural vessels: In 5–8 thin tubes, gradually enlarging; in 9–11 thick, moniliform ‘hearts’ connected posteriorly with ventral vessel. *Nephridia*: Two small pairs; dorsal pairs with long, thin tubes; ventral pairs with shorter tubes, close to median body line; in preclitellar segments nephridia much larger than those from posterior segments.

Reproductive organs: *Spermiductal funnels*: Holandric arrangement (in 10 and 11); two pairs of funnels, of similar size and appearance, enclosed in sacs, closely connected with vesiculae seminales. *Seminal vesicles*: In 10 and 11; moderately-sized, linked with testis sacs. *Spermathecae*: One pair per segment; minute ampullae close to septa 11/12, 12/13, 13/14. *Ovaries*: In 13. *Genital glands*: Six pairs associated with papillae in *ab* setae lines; in 12–16 and 22 or 23; of medium size, composed of two flat, half-oval structures.

Biological notes: Found in hard soil of indigenous grassland and savannah, on a river bank and in a grazing field. In life, specimens are plump, clumsy with slow movement. When preserved they reveal evident contraction. The mature and juvenile specimens, collected in November, after several rainy days, were active. Small casts were observed on the surface of the ground. A number of very small juveniles indicates breeding activity in early summer. When there has been little rain and the soil lacks moisture, specimens extend their anabiotic state; this was observed in December 1995 near Lydenburg.

Associated with indigenous microchaetids (*Microchaetus natalensis* (Kinberg), *Proandricus* sp.), and with introduced species of Lumbricidae (*Dendrobaena rubida* (Savigny)) and Megascolecidae (species from the *Pheretima* group).

Distribution: Known from a few localities in northern KwaZulu-Natal and from Mpumalanga. Occurs possibly in neighbouring grasslands in north-eastern South Africa and probably in Swaziland.

Discussion: A distinctive species with characteristic position of spermathecal pores in intersegmental furrows 11/12, 12/13, 13/14, and shape of tubercula pubertatis. Both characters have not been observed in other *Tritogenia* species.

***Tritogenia silvicola* sp. n.**

Fig. 22

Etymology: *L. silvicola* = inhabiting forest. Refers to the biotope where the species was collected.

Material examined: *Northern Province*: Holotype: clitellate specimen NMSA/Olig.02327, Entabeni State Forest (23°01'S:30°15'E), Entabeni Peak, from red, moist soil, 9 December 1995. Paratypes: 1 semi-mature, 3 juveniles, 2 abscised parts, all collected with holotype, NMSA/Olig.02244; from type locality, 8 December 1995, 1 clitellate, NMSA/Olig.02243; all material collected by JDP & TL.

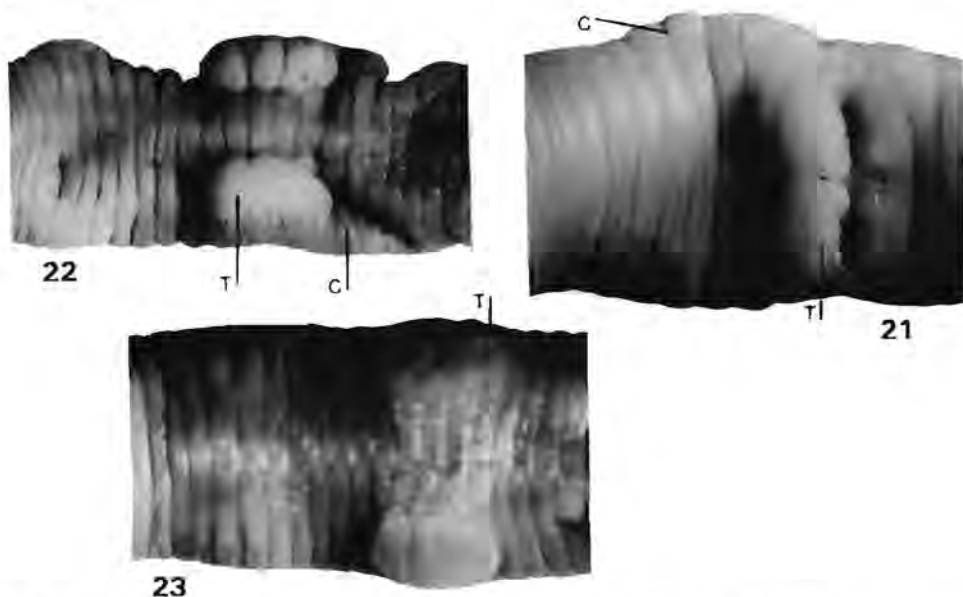
Description based on holotype and paratypes.

External characters:

General: Body in life clumsy. *Colour*: In life yellowish-grey. Preserved grey. *Dimensions*: Preserved and contracted: holotype 73 mm long, 4 mm wide at 10, 6

mm at tubercula pubertatis; clitellate paratypes: 48–68 mm long; juveniles 45–50. *Segment number*: Holotype 129; paratypes 118–121. *Prostomium*: Prolobous, small. *Segmentation*: Secondary annulation present; 1–3 simple, 1–2 with longitudinal grooves; 4–8 with two simple ringlets, similar in size and appearance; 9 with two ringlets, second ringlet shorter than first; 10 and the following segments simple, postclitellarly with random annulation. *Setae*: Minute, closely paired; first pairs of *ab* on first ringlet of 8 or 9; setal pairs *cd* externally not observed; probably deeply embedded in body tissue. *Female pores*: On 14 above *ab* setal lines. *Male pores*: Probably in 19. *Spermathecal pores*: In intersegmental furrows 10/11, 11/12, 12/13, clear, small swellings in line of dorsal border of tubercula pubertatis.

Clitellar region (Fig. 22): *Clitellum*: Saddle-shaped, clearly distinguished anteriorly and posteriorly; holotype and paratypes on 13–23. *Tubercula pubertatis*: On 1/n18–1/n22; oval ridges, glandular, segmented; anteriorly commence slightly above *ab* setal lines; extending backward partially over segment 22; dorsal border at ventral clitellar edge; ventrally terminate close to *ab* setal lines, separated widely by broad segmented field. *Papillae*: Paired swellings on 10, 11, 22, 23, corresponding to genital glands.



Figs 21–23. *Tritogenia* species, clitellar region, ventral view. 21. *T. liversagei* sp. n. 22. *T. silvicola* sp. n. 23. *T. turneri* sp. n. [C = clitellum; T = tuberculum pubertatis.]

Internal characters:

Septa: 4/5 thickened moderately, 5/6, 6/7 thickened very much, 7/8, 8/9 thickened very little; 9/10 and 10/11 very thin, rudimentary; other septa postclitellarly thin, strong. *Gizzard*: Commences in 6, extends and occupies whole of 7. *Calciferous glands*: Commencing in 10, extending to 9; not stalked, widely separated ventrally, narrowly separated dorsally. *Intestine*: Commences in 13. *Typhlosole*: In holotype

commences in 20, terminates at *ca.* 60. *Dorsal blood vessel*: Doubled in 4–11; in 4–7 thin tubes, in 8 somewhat enlarged, in 9–11 distinctly enlarged. *Paired dorsoventral commissural vessels*: 4–8 thin tubes, 9–11 enlarged, moniliform ‘hearts’. *Nephridia*: Two pairs per segment; dorsal pairs slightly larger than ventral ones.

Reproductive organs: *Spermiductal funnels*: Holandric arrangement (in 10 and 11); enclosed in one testis sac. *Vasa deferentia*: Ducts run to segment 19 where they enter body wall. *Spermathecae*: Moderate ampullae with long necks; one pair per segment, near septa 10/11, 11/12, 12/13. *Seminal vesicles*: Small sacs, twice-folded, in 10 and 11, closely attached to sacs of spermiductal funnels. *Genital glands*: In 10, 11, 22, 23; round, flat, moderate in size; corresponding to papillae.

Biological notes: Collected in indigenous forest, located near *Pinus* plantation. Population apparently small (nearly 2 square metres dug to a depth of 50 cm produced only three juveniles and one clitellate specimen). All three juveniles had partly developed papillae and tubercula pubertatis, suggesting emergence from a cocoon in early summer. The presence of sperm in the spermiductal funnels and in the spermathecae suggests sexual activity during early summer rains.

Distribution: Known only from the type locality in Northern Province.

Discussion: Similar to *turneri* sp. n. Both species are alike in general appearance, and in the number and position of spermathecal pores and calciferous glands. They differ in the shape and position of the clitellum and the tubercula pubertatis, and the number and position of papillae and genital glands.

***Tritogenia turneri* sp. n.**

Fig. 23

Etymology: Named for Mr James Turner, who collected and donated this species to the Natal Museum.

Material examined: *Northern Province*: Holotype: clitellate NMSA/Olig.02318, Haenertsburg (23°58'S:29°58'E), collected on soil surface after heavy rain, February 1996, J. Turner; kept in soil in small bucket until 29 April 1996, when specimens were preserved. Paratypes: 7 mature specimens with incompletely developed clitellum (possibly absorbed, when in captivity), and 1 juvenile, all collected with holotype, and preserved 29 April 1996, NMSA/Olig.02319.

Description based on holotype and paratype.

External characters:

General: Body in life clumsy. Preserved with contracted segments. *Colour*: In life yellowish-grey. Preserved grey. *Dimensions*: Preserved and contracted: Holotype 82 mm long, 6 mm wide at 10, 7 mm at tubercula pubertatis; paratypes 70–100 mm long. *Segment number*: Holotype 90; paratypes 99–116. *Prostomium*: Epilobious, open; with longitudinal grooves. *Segmentation*: 1–3 simple, 1–2 with longitudinal grooves; 4–8 with two simple ringlets, similar in size and appearance; 9 with two ringlets, second ringlet shorter than first; 10 and the following segments simple, randomly annulated. *Setae*: Minute, closely paired; first pairs of *ab* on first ringlet of 7; setal pairs *cd* not detected. *Female pores*: On 14 above *ab* setal lines. *Male pores*:

Probably on 19, where there are small invaginations near dorsal line of tubercula pubertatis. *Spermathecal pores*: In intersegmental furrows 10/11, 11/12, 12/13.

Clitellar region (Fig. 23): *Clitellum*: Saddle-shaped, not clearly defined; holotype 13–25; paratypes 13–25, 26, not distinctly demarcated from other segments. *Tubercula pubertatis*: On 18–22; oval, glandular with segmented ridges; commence at ventral line of clitellum, extend to *ab* setal lines, terminating far from median body line; broadly separated ventrally. *Papillae*: Paired, round swellings on 10–13 and 26 with small blisters; 10, 11, 12, 26, corresponding to genital glands.

Internal characters:

Septa: 4/5 thin, strong; 5/6 and 6/7 thickened more than 7/8 or 8/9; other septa thin. *Gizzard*: In 6–7; septum 6/7 adherent in 1/5 of gizzard length. *Calciferous glands*: In 10, not stalked, widely separated ventrally, narrowly separated dorsally. *Intestine*: Commences in 13. *Typhlosole*: In paratype (with 106 segments) commencing in area of 20, terminates in 65. *Dorsal blood vessel*: Doubled in 4–11; in 4–7 thin tubes, in 8 somewhat enlarged, in 9–11 distinctly enlarged. *Paired dorsoventral commissural vessels*: 4–8 thin tubes, 9–11 enlarged, moniliform 'hearts'. *Nephridia*: Two pairs per segment; dorsal pairs slightly larger than ventral ones.

Reproductive organs: *Spermiductal funnels*: Holandric arrangement (in 10 and 11); enclosed in testis sacs. *Spermathecae*: Tiny ampullae with long necks; near septa 10/11, 11/12, 12/13. *Seminal vesicles*: Small, twice-folded, in 10 and 11, closely attached to sacs of spermiductal funnels. *Genital glands*: In 10, 11, 12, 26; four-branched, divided by narrow grooves, glandular, corresponding to external papillae.

Biological notes: According to Mr J. Turner, many specimens were collected in February after heavy rain, on pathways near his farm house, and in gardens. Specimens were kept in a small container for more than two months. When the sample arrived at the Natal Museum in April, only nine living specimens were found in the container; each partly covered by small particles of soil bonded to the tube-like, small cluster. Although the specimens possessed the tubercula pubertatis, their clitella were not clearly evident. It is difficult to decide on the state of maturity. The slightly brownish colour and very thin clitellar layer suggest the absorption of clitellar tissue; similar regression has been observed in other microchaetids affected by unfavourable conditions. Dissected specimens contain in their gut small particles of soil and organic matter, showing that they were not in an anabiotic state.

Distribution: Known only from the type locality, in the Northern Province.

Discussion: Similar to *silvicola* sp. n. in general appearance, and the number and position of spermathecal pores. The species differ in the shape and position of the clitellum and tubercula pubertatis, and the number and position of papillae and genital glands.

NOTES ON BIOLOGY AND DISTRIBUTION

Tritogenia species, although primitive amongst the microchaetids, are anatomically well-equipped to live in soils subjected to extended seasonal dryness. The compact body, with relatively small number of segments (in many species less than one hundred), with three or four thickened anterior septa, facilitates contraction of the

segments; the muscular gizzard, located in two segments, increases the stiffening and strength of the anterior part of the body. These qualities increase the ability to burrow in hard soil; during prolonged dryness most of the species go into an anabiotic state. Not much is known of the biology of the genus, on the deposition of cocoons, and development of the embryos and juveniles. However, it was observed in two species (*ataxia* and *diversa*), that very young specimens respond to extended dryness by developing the anabiotic state. Collected cocoons of *lunata* contained three juveniles.

On present evidence, *Tritogenia* is a taxonomically distinctive element of the endemic South African terrestrial oligochaete fauna. Although now known to include many species, this genus proves to be geographically more restricted than the equally speciose microchaetid genera *Microchaetus* and *Proandricus*.

A notable concentration of 25 species occurs in KwaZulu-Natal (Table 3), between the boundary of this province at about 31°S, where a species occurs on the Ngele Range, and the northern section in the region of the Pongola catchment. In KwaZulu-Natal most species occur on the uplands east of the Drakensberg Escarpment, particularly on scarps, around wetlands and seepages, and in montane zones, where indigenous Afromontane forests and primary grasslands are favoured by higher rainfall and mistbelt conditions. Species preferring grasslands in this area are: *annetteae*, *curta*, *diversa*, *herbana*, *howickiana*, *karkloofia*, *melmothana*, *miniseta*, *monosticha*, *mucosa*, *shawi*, *zuluensis*, and probably also *crassa*, *soleata* and *sulcata*, for which little information exists. *T. ataxia* and *liversagei* were collected in grassland soils of KwaZulu-Natal and also in undisturbed riparian sites in Mpumalanga. *T. alveata*, *douglasi*, *ngelensis*, *ngomensis* and *curiosa* occur in forests on escarpments parallel to the coast. *T. insolita*, *koilia* and *lunata* were found in forested kloofs and gorges.

North of KwaZulu-Natal the genus extends along the Drakensberg Escarpment of the Transvaal and in adjoining eastern highveld areas characterised by high and regular rainfall. *T. palusicola* and *liversagei* occur in grassland. *T. silvicola* has been found in indigenous forest surrounded by *Pinus* plantation, at the eastern end of the Soutpansberg Range, and *kruegeri* has been collected from grassland on its southern face. It is possible that these two species represent the northern limit of the genus. There is also a limited extension by *grisea* to the west; although this species was described from the 'Orange Free State, Bloemfontein' [29°06'S:26°16'E] by Michaelsen (1902), it was also reported by Plisko & Zicsi (1991) from Skandinavia Drift (26°56'S:27°03'E), Nelspruit (25°28'S:31°00'E) and Ohrigstad (24°43'S:30°36'E). These localities are widely separated, and the last three were associated with river banks, suggesting the possibility of transportation by natural factors or by man.

Most *Tritogenia* species are known only from their type locality. Among those described in this paper, only *ataxia*, *herbana* and *liversagei* were collected from more than one locality. Of the earlier known species, *howickiana*, *kruegeri*, *mucosa* and *shawi* have been found at more than one site (Plisko 1992), and *grisea* has been noted from widely separated localities (Plisko & Zicsi 1991). Only two places are known where two species occur together: *insolita* and *koilia* were found in Kranskop forest, and *alveata* and *ngelensis* in Ngele forest. At both sites other indigenous and also introduced oligochaete species were found.

TABLE 3

Tritogenia species-groups arranged according to their occurrence in biotopes.

Sp. group	Species	Grassland	Forest	Other	Unknown	Region
grisea:	<i>monosticha</i>	+	–	–	–	KwaZulu-Natal;
	<i>ngomensis</i>	–	+	–	–	KwaZulu-Natal;
	<i>krugeri</i>	+	+	–	–	Mpumalanga, Northern Province;
	<i>grisea</i>	–	–	+	–	Free State, North West Province, Mpumalanga;
	<i>benhami</i>	–	–	–	+	Unknown;
sulcata:	<i>annetteae</i>	+	–	–	–	KwaZulu-Natal;
	<i>diversa</i>	+	–	–	–	KwaZulu-Natal;
	<i>karkloofia</i>	+	–	–	–	KwaZulu-Natal;
	<i>miniseta</i>	+	–	–	–	KwaZulu-Natal;
	<i>shawii</i>	+	–	–	–	KwaZulu-Natal;
	<i>howickiana</i>	+	–	+	–	KwaZulu-Natal;
	<i>herbana</i>	+	–	–	–	KwaZulu-Natal, Mpumalanga;
	<i>liversagei</i>	+	–	+	–	KwaZulu-Natal, Mpumalanga;
	<i>palusicola</i>	+	–	–	–	Mpumalanga;
	<i>curta</i>	+	+	–	–	KwaZulu-Natal;
	<i>curiosa</i>	–	+	–	–	KwaZulu-Natal;
	<i>douglasie</i>	–	+	–	–	KwaZulu-Natal;
	<i>insolita</i>	–	+	–	–	KwaZulu-Natal;
	<i>lunata</i>	–	+	–	–	KwaZulu-Natal;
	<i>ngelensis</i>	–	+	–	–	KwaZulu-Natal;
	<i>silvicola</i>	–	+	–	–	Northern Province;
	<i>turneri</i>	–	–	+	–	Northern Province;
	<i>soleata</i>	–	–	–	+	KwaZulu-Natal;
	<i>sulcata</i>	–	–	–	+	KwaZulu-Natal;
mucosa:	<i>mucosa</i>	+	–	–	–	KwaZulu-Natal;
	<i>ataxia</i>	+	–	+	–	KwaZulu-Natal, Mpumalanga;
	<i>alveata</i>	–	+	–	–	KwaZulu-Natal;
	<i>koilia</i>	–	+	–	–	KwaZulu-Natal;
zuluensis:	<i>crassa</i>	–	–	–	+	KwaZulu-Natal;
	<i>melmothana</i>	+	–	–	–	KwaZulu-Natal;
	<i>zuluensis</i>	+	–	–	–	KwaZulu-Natal;

There appear to be more species inhabiting grasslands than Afromontane forest; sixteen species have been collected in grassland, eleven species in forest (Table 3). Two species, *curta* and *kruegeri*, have been found in both forest and grassland biotopes. Two species, *grisea* and *turneri*, occur in biotopes other than grassland or forest. In view of the present fragmented pattern of forest distribution, it appears that speciation by vicariance of formerly more widespread forest populations, may have occurred.

Data derived from the present study reveal the general outline of the biogeography of *Tritogenia*. Further collecting will probably reveal more new species in regions such as Swaziland, the northern Drakensberg, and montane areas of Mpumalanga and Northern Province. However, it seems likely that, as with other Microchaetidae, many *Tritogenia* species are at risk of extinction through habitat alteration and

destruction. No species has been found in intensively cultivated areas, and no evidence exists that these earthworms can adapt to disturbed habitats.

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